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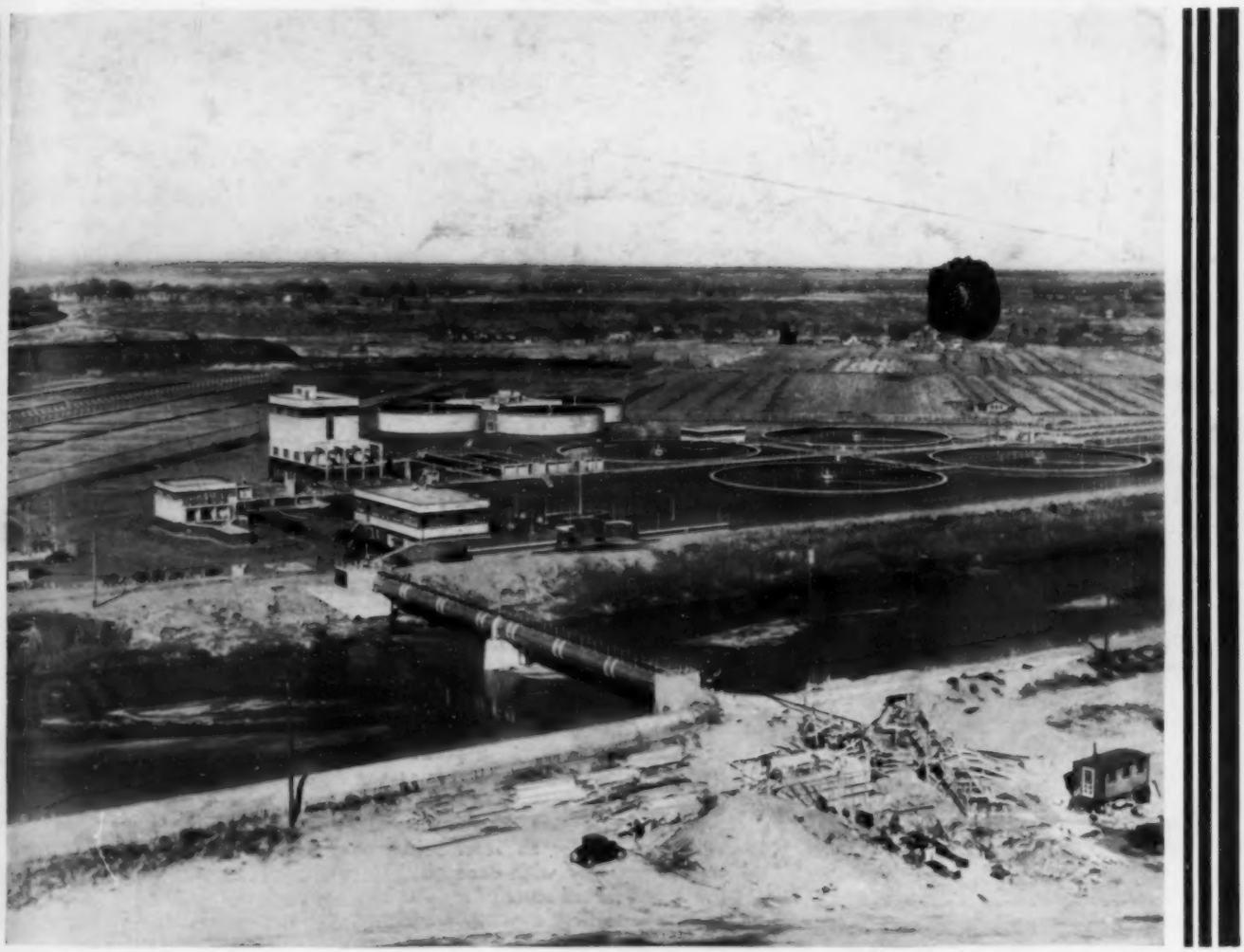

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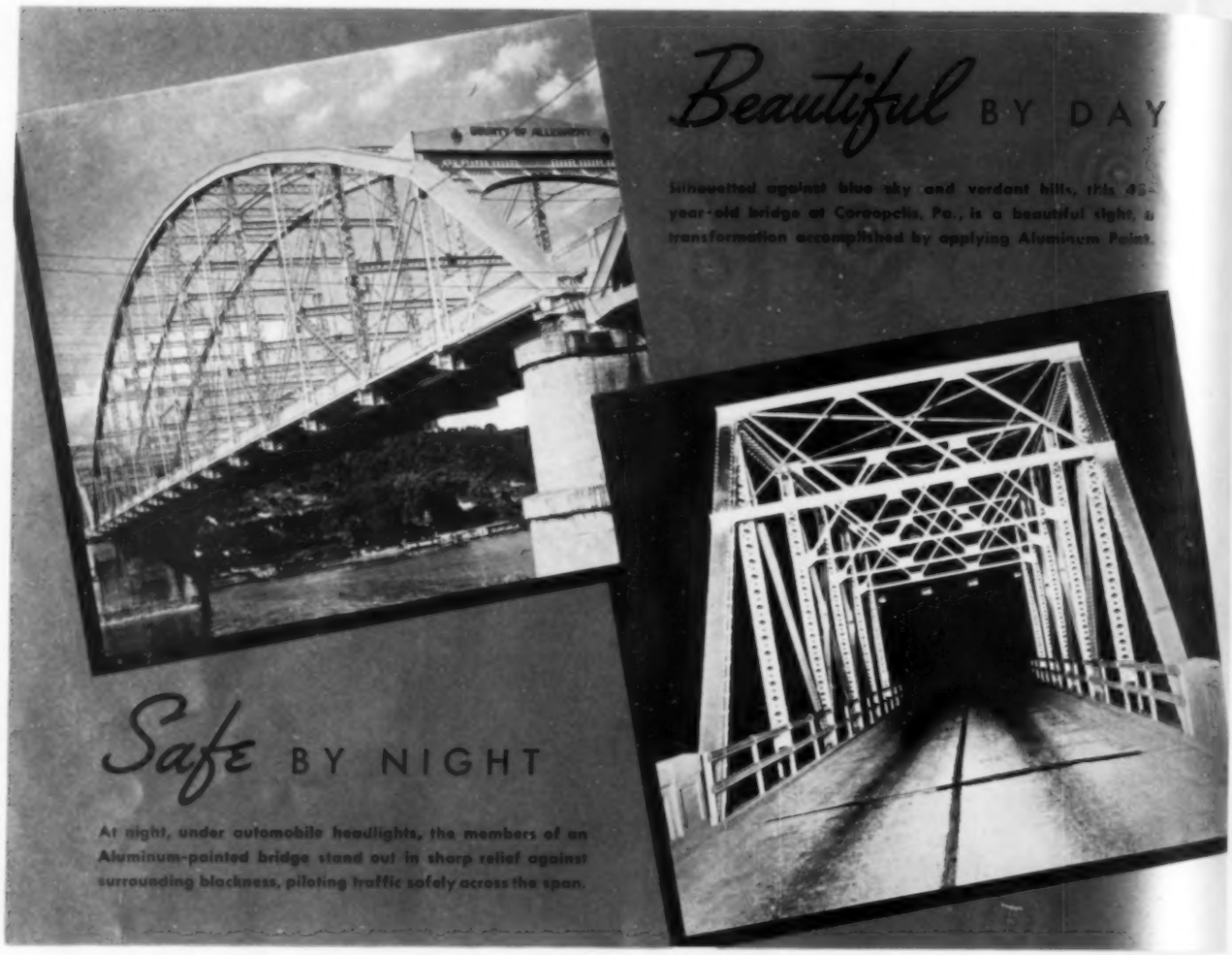
Articles in This Issue Discuss the Status of Sewage Disposal in the Far West in General, and This Project in Particular

Volume 8 — *Number 9*

SEPTEMBER 1938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HENRY D. DEWELL is a 1906 graduate of the University of California. Early experience included service as chief structural engineer of the Panama International Exposition. Since 1915 he has been in private practice.

E. B. BLACK has had 30 years' experience in civil, sanitary, and valuation engineering in the Middle West. His firm, Black and Veatch, has designed many water and sewerage projects, including sewage treatment plants at Wichita, El Paso, Hot Springs, Tucson, and Denver.

ROGER W. ARMSTRONG was graduated from Tufts College in 1902. Except for 3 years as operating engineer of water and sewage plants at Camp Upton and as designing engineer for projected water supply for Athens, Greece, he has served with the New York Board of Water Supply since 1906.

L. I. HEWES began his highway engineering work in Massachusetts in 1897. He was appointed senior highway engineer with the Office of Public Roads in 1911, and after a series of promotions received his present appointment in 1920.

RAYMOND F. DAWSON (Purdue University, 1923) has been testing engineer in the Bureau of Engineering Research, University of Texas, for the past 10 years. He is in charge of the laboratory for materials testing and research; also teaches soil mechanics in the Civil Engineering Department.

RALPH BUDD, president, C.B.E.Q.R.R., and in railroad service since 1899, has taken a leading part in advancing the use of light-weight railroad equipment. Prior to 1932 he was president of the Great Northern, and responsible for its Cascade Tunnel and electrification that shortened transcontinental passenger schedules by 12 hours in 1929.

JOHN R. DAWSON (Rice Institute, 1929) has been employed by the National Advisory Committee for Aeronautics since 1930. He helped design the tank he describes, and since its completion has been engaged in testing seaplane floats and hulls and designing apparatus for such tests.

H. K. GIDLEY, a 1929 graduate of the University of West Virginia, has been with the health department of that state since 1930, except for two years as sanitary engineer with the W. K. Kellogg Foundation in Michigan.

ROBERT RIDGWAY covers his early experiences adequately in his own article. Suffice it to add that his distinguished career in public service culminated in 3 years as chief engineer of New York City's Transit Commission and 8 years in the same capacity with the Board of Transportation.

DANA E. KEPNER (Massachusetts Institute of Technology, 1921) was sanitary engineer for the Colorado State Board of Health from 1924 to 1929. Since then, he has been representing various manufacturers in the sale and servicing of equipment for water purification and sewage treatment.

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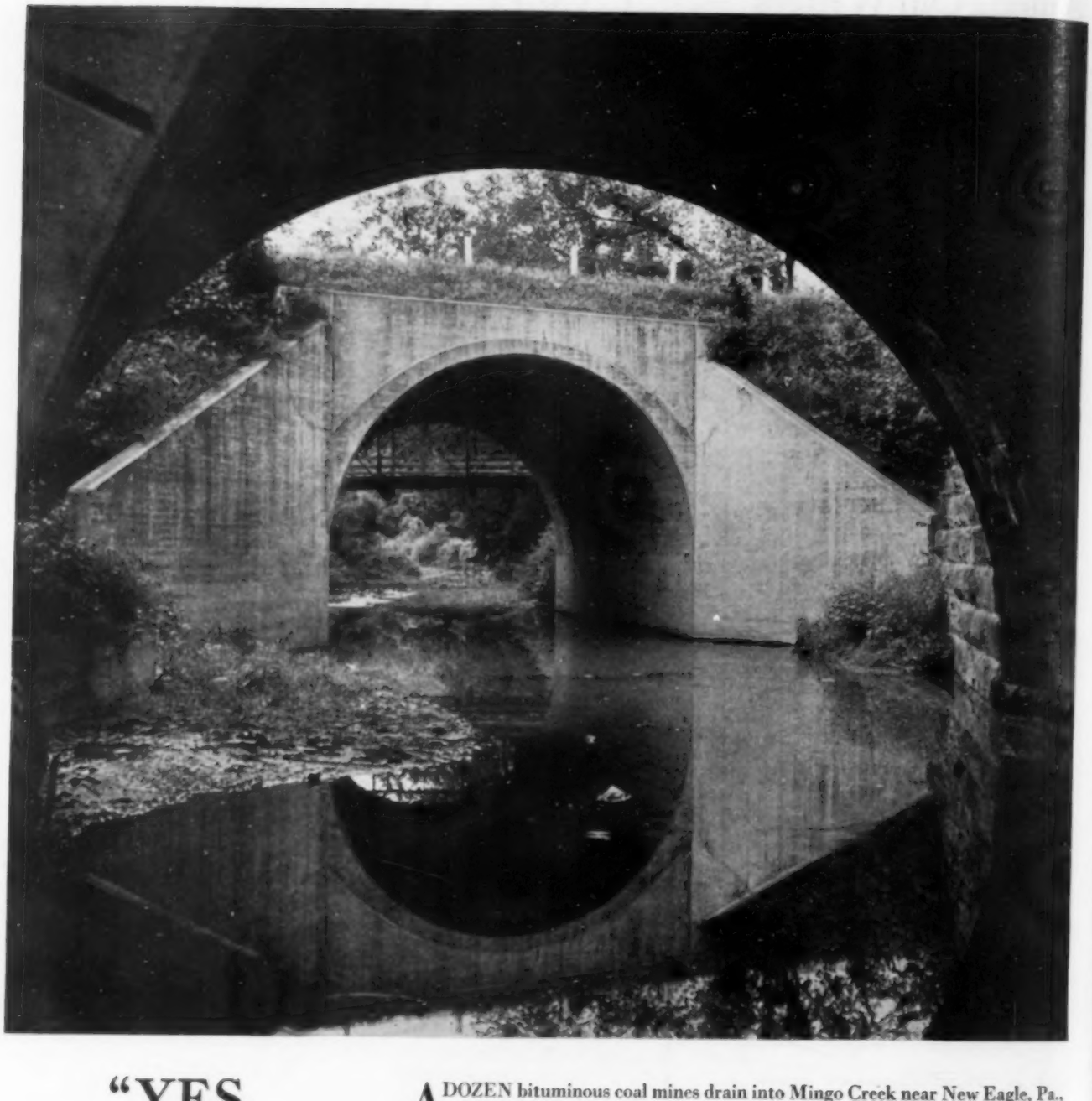

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

City Planning and the Engineer

Outlining the Responsibilities of the Profession in Rationally Developing Our Communities

By HAROLD M. LEWIS, M. AM. SOC. C.E.

CHAIRMAN CITY PLANNING DIVISION, AMERICAN SOCIETY OF CIVIL ENGINEERS
CHIEF ENGINEER AND SECRETARY, REGIONAL PLAN ASSOCIATION, INC., NEW YORK, N.Y.

CITY planning is an old art that is taking on new life. Although it has been practiced for many centuries, it has taken on an added significance with the recent great increases in the size of urban communities. Modern city planning is largely a development of the last twenty-five years, but in both its technique and the extent of its application it has made rapid strides within the last ten years.

In the early development of the United States, civil engineers were the intrepid pioneers who met the needs of an expanding territory by laying out the first crude transportation routes across the country. But as the frontiers were narrowed, these men, having won this important battle, returned to public service in the cities. Thus the city engineers became the original city planners in America. They have, however, become absorbed in the pressing problems of construction and maintenance and in taking care of the immediate needs of their communities. By the same token, it is seldom that they have had the time or the staff to look very far into the future. As a result many communities are today faced with difficult tasks in their immediate development.

The Engineer Is Largely Responsible for Urban Problems.—City planning is not, and probably never will be, the field of a single profession. Its leaders have come from various professions any one of which can supply the basic technical training which is essential. For example, engineers, architects, and landscape architects have each made essential contributions. In addition the legal profession has added its important quota to development in the general field.

Population centers would never have grown to their present sizes, however, were it not for the inventions of engineers, who have thus promoted and made possible the modern city. These inventions include the steel-framed building, high-speed electric transportation, the telephone, and the motor vehicle, each of which has brought problems in its wake. Urban growth has taken the form of both large individual cities and metropolitan districts, and has reached its peak in New York City and its environs. It has developed problems which require for their solution the comprehensive viewpoint of the city planner. Having done so much to create these problems, the engineer cannot shirk the responsibility of finding an answer for them. It is certainly well within his powers to solve the puzzles of city planning.

Broadening of Engineering and Field.—Obviously the engineer must be more than a mere technician. This has been recognized in recent years by the engineering schools themselves, which have been broadening their courses, without overlooking the importance of a thorough technical foundation, to ensure that their graduates will be better fitted to fill executive positions. However, the number of engineers who are practicing city planning as their main activity is still small. This may be partly because the average engineering course still devotes little time, if any, to this particular subject.

If the engineer is to broaden his field, he must consider any project he designs as a part of a plan for the community, whether urban or rural, within which it is located. I believe that students in all branches of engineering should be at least "exposed" during their college training to the general principles of city planning. While it will continue to be true that only a small percentage of them will become professional city planners, they will all be better engineers in whatever field, once they have acquired an appreciation of city planning.

Development of Comprehensive Planning.—Most of the early planning efforts in the United States were based upon a desire to create "a city beautiful." The outstanding feature was generally a civic center; indeed, many such plans did not extend beyond the immediate vicinity of the center. Some of these plans were not very practical and failed to arouse a general interest. As a result they were often filed in libraries and pigeonholes and failed to lead to real results.

The modern city plan is based on making a community not only more attractive in appearance but also a more convenient, comfortable, and healthy place in which to live. Efficiency, combined with the earlier objectives, has now become the watchword.

With the rapid development of the automobile at the beginning of the current century, city plans became

primarily street and highway layouts. It was soon realized that highways could not be planned successfully without a thorough study of the land that would front upon them. And so the field of city planning was broadened, and the term "comprehensive planning" came to be used. This involved working out a pattern of land uses, and fitting these uses together into a single plan—which would be established by law—as well as systems of highways, railroads, terminals, parks, playgrounds, schools, water supply, sewage, and refuse disposal. These all have their place in the modern city, and if they are to be supplied efficiently and economically they must be properly related.

Quantity as Well as Quality Must Be Regulated.—The municipality that commits itself to establishing high standards of quality for its public services, without adequately studying probable future needs and limiting its construction program to such needs, will soon find itself in financial difficulties. This has been the experience of cities which have falsely assumed that their population would continue to increase at rapid rates and that the demand for new business and residential land would increase correspondingly. Of course, on the other hand, there have been many cities that have grown beyond any possible expectation of the city fathers who were in control fifty or a hundred years ago.

Statisticians are now agreed that the next twenty to thirty years will see a rapid decline in the rates of growth of urban areas. The city planner should make careful studies not only of the future growth of population but also of its distribution within the area in question. Engineers have long made population estimates, and they are well fitted for this part of the city planner's task.

The uses of private land are regulated by zoning ordinances. It is estimated that over 1,400 of the cities, towns, boroughs, and villages in the United States have adopted such regulations. Many times this number are still without this protection. Most of the zoning has been done more for the purpose of protecting the quality of the areas zoned than to restrict the quantity allocated to various types of use. In many cases, several times as much area has been set aside for business districts and multi-family residential districts as will ever be needed for such purposes. It is now generally recognized that such ordinances should be overhauled so as to fit more closely the probable future pattern of the city.

Another type of restriction that is still in a formative stage is the control of premature and excess subdivision of urban land. Here again quantity control is as important as the control of quality. Many hundreds of thousands of building lots staked out on the edges of our large cities will never be needed for homes under the most generous estimates of population growth. City planners are trying to find some means, direct or indirect, of preventing this wasteful cutting up of land which might better be kept for agriculture, forestry, or recreation.

New Trends in Planning.—The growth of metropolitan districts, already referred to, led to an expansion of city planning to cover metropolitan areas, under the name of "regional planning." Starting in 1909 with the Burnham Plan of Chicago, which extended out for about 30 miles from the center of the city, the movement spread to the Regional Plan of New York and Its Environs undertaken by a citizens' committee in 1921 and financed by the Russell Sage Foundation. Later came similar plans for the Philadelphia Tri-State Regional District, and for Los Angeles, St. Louis, and Milwaukee.

During the early years of the recent depression, city planning suffered from the cutting off of appropriations to planning boards. This was on the theory that they were a luxury—good enough in prosperous times but something that might well be postponed when money is scarce. It soon developed, however, that the city with a plan was at a great advantage when it came to developing emergency public works. Federal agencies stressed the importance of knowing that a project they were helping to finance was a part of a comprehensive plan.

So the last three or four years have seen the creation of many new official boards and commissions. Many of them started out with work-relief staffs to gather necessary facts and prepare basic maps. Now they are gradually receiving financial support from regular municipal and county budgets. The future of planning is brighter than ever before, provided that it be kept on the right track so that it will turn out practical plans.

The federal government, through the National Planning Board and its successors, the National Resources Board, and the National Resources Committee, has been promoting the establishment of state planning boards throughout the nation. As a result such boards were operating in 1937 in 47 of the 48 states. In several cases interstate regional planning agencies have been set up, and the National Resources Committee has made a substantial start on national planning.

Special Requirements of a City Planner.—In addition to a sound technical training, every engineer or other professional man who desires to follow city planning as a career, should develop some important qualities. In particular, he should have a large amount of tact, as city planning is largely advisory and the planner must depend on other officials for carrying out his plans. He will have to review projects initiated by others, and so he should keep an open mind as to what is the best plan until he has studied the problem from all points of view. He must be able to write clear reports in good English, and must have some ability in public speaking so as to present his case clearly before officials or citizen groups.

Patience is essential, for it takes many years to get new projects carried out. And when they are carried out, the credit generally goes, not to the city planner, but to the official who happens to be in office when the project is constructed. The city planner must have imagination, as he deals with many subjects and with conditions not only as they are today, but as they are likely to be many years hence.

Engineers on Planning Boards.—It has often been claimed that engineers are slow to take their proper place in civic affairs. Members of planning boards and commissions are generally unpaid, so that service upon them demands in advance that the appointee be endowed generously with public spirit and interest. The engineer is especially fitted for this service, and many planning boards today have such members. He should welcome such opportunities to serve; I know of no better way in which he can demonstrate to the public at large the contribution of engineering to the general welfare.

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CIVIL ENGINEERING

SEPTEMBER 1938

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VOLUME 8 NUMBER 9

The Board of Direction Meets at Salt Lake City

A Running Account of the Recent Sessions of the Society's Governing Body

IN accordance with the Constitution of the Society, the Board of Direction meets five times a year. Two of these meetings are always held at Headquarters in New York, in conjunction with the Annual (January) Meeting of the Society. (The second of the New York meetings is a "holdover" session at which the newly elected members take their places on the Board and the new budget and committee appointments are approved.) The other three meetings—in April, July, and October—are held at cities widely scattered over the United States and are preliminary to the spring, summer, and fall meetings of the Society.

While it thus may be properly said that the recent Board meeting at Salt Lake City was called "at the time of the Annual Convention," the Board and its committees actually met, as is usual, on the three days preceding the Convention. The various committees, with 22 members of the Board present, convened on Sunday, July 17—morning, afternoon, and evening—to discuss their respective assignments and prepare such recommendations to the Board as were required. The Board itself began its meetings Monday morning and held four sessions—one less than the usual number.

COMMITTEE MEETINGS

In its Sunday session the Executive Committee devoted six hours to an agenda of some 22 items. This committee not only gives guidance to the Board on all financial matters and reviews all public statements made by the Society, but also relieves the Board of the necessity of studying in detail many minor matters which, nevertheless, require Board action.

The Committee on Publications began its Sunday session with considerable work already behind it, for numerous matters had already been disposed of in a long preliminary session on the train en route to Salt Lake. This "en route" meeting was devoted to a discussion of ways and means of making the Society's publications—particularly PROCEEDINGS and CIVIL ENGINEERING—even more effective and representative of Society activities. Problems of publication cost, contracts for paper and printing, as well as plans and proposals for future publications, methods and policies as regards reprints, and other "policy" problems were discussed. It was thus possible to devote the six-hour Sunday session at Salt Lake City largely to the examination of papers submitted for publication and the planning of the publication schedule. In selecting papers, the committee takes into account the percentage of the Society's membership that is interested in each special field, as shown by the membership lists of the various Technical Divisions. Primarily, however, it is guided by the opinions expressed by those members of the Society who, because of special experience and interests, have been selected to review each paper. At least three, and frequently five or six, "reviewers" are asked to report on every paper submitted for PROCEEDINGS.

Another committee that always has a long and laborious session is the Committee on Membership Qualifications. All applications for admission and transfer come before it, and at the Salt Lake meetings some eight and a half hours of detailed study were given to 146 cases which had been referred to this group of six directors. As explained later in this article, several changes have been made in the routine and detail of applications which appear to have increased the effectiveness of this work and to have decreased materially the labor formerly given to it by the Board.

The Committee on Professional Conduct—"unprofessional" conduct, as it might well be called—also spent some time Sunday in reviewing two cases, one a most perplexing and involved problem. After full study of the facts, it reported its conclusions for further action by the Board.

The Committee on Districts and Zones also met Sunday to discuss further some of the problems of dividing the continental United States and its possessions into suitable areas in accordance with the new Local Section plan adopted by the Board last year. While some minor adjustments still remain to be made, and some new Sections are now being organized, this plan, which requires that all members of the Society be assigned to some Local Section, will soon be fully effective. As someone has said, the American Society of Civil Engineers some forty or fifty years ago was "a local society with national aspirations." Many changes have taken place in the intervening years

A national professional society in these days of unrest and readjustment faces many problems of vital interest to its membership—must make decisions on matters that will vitally affect its future and its standing as a representative of a long-established and increasingly important profession.

The Committee on Publications feels that the membership of the American Society of Civil Engineers will be interested in knowing more fully of the problems which the Board considers at its quarterly meetings, and takes this opportunity to present an abstract of the recent meeting of the Board at Salt Lake City, July 17, 18, 19, 1938.

and the assignment of all members to Local Sections is an outstanding current example of the steps taken by the Society to increase its effectiveness as a truly national engineering body.

THE BOARD MEETING

This national character of the Society today is well illustrated by the distribution of the Board membership. The Board consists of 26 members elected by the membership of the Society, and resident all over the United States and all but one member (Past-President Hill, who was held at home by illness) attended the Salt Lake meeting. In addition to the officers, the Secretary and the Treasurer, several staff members are usually present—"on the side lines"—to answer special questions. These included the Field Secretary, the Manager of Publications, and the Assistant to the Secretary.

Many of the items on the agenda of the Board meetings are more or less routine matters—minutes, routine committee reports, statements for record, etc. On the other hand many of the committee reports demand most careful and thorough study, and the Board gives much of its time to these reports.

At Salt Lake the Executive Committee, naturally the first to report, offered recommendations on 15 items which were approved by the Board. Two of these actions are of special interest. One of them recommended the cooperation of the Society with the Institution of Civil Engineers of Great Britain and the Engineering Institute of Canada in a joint meeting to be held, probably during Labor Day week of next year, at the World's Fair in New York. A special committee has been appointed to perfect these plans.

The other item involved final action on the abolition of a committee of the Board—the Committee on Professional Activities. In recent years the duties of this committee, never very clearly defined, have been fully met by other committees, and accordingly the By-Laws were amended to do away with it.

Actions taken by the Executive Committee and adopted by the Board as its own actions included: approval of a schedule of fees for structural engineering and foundation engineering connected with the work of the Federal Housing Administration and the U. S. Housing Authority; the designation of Douglas C. Davis, U. S. Waterways Experiment Station at Vicksburg, Miss., as the 1938–1939 Freeman Scholar; the delegation to the Committee on Technical Procedure of a study of future meeting places; and approval of specific sales and purchases of securities representing the Society's funds and the several special funds of which the Society is custodian.

The second item on the agenda was the report from the Committee on Publications. This committee does not, in general, convey to the Board of Direction any considerable part of the minutiae of its work. It generally places before the Board only such proposed changes of policy as seem to the committee desirable for discussion by the full membership of the Board.

The Board discussed at length the report of the Committee on Professional Conduct, the committee making careful explanation of the circumstances which led to its recommendations, and the Board members making inquiry of the committee as to details. It was only after nearly unanimous agreement of opinion had been obtained that the Board took action with respect to the three matters placed before it. One action was to direct that admonition be made to one member of the Society who the Board decided had been unfair to his fellow members in that, while on salary in a governmental unit, he had used the advantages of his salaried position to compete unfairly with other engineers.

The noon recess was, as usual, the occasion for a special luncheon tendered by the Board to the Local Section officers and committee on arrangements. Also during this period the Committee on Honorary Membership met. The committee consists of the President of the Society, two Past-Presidents, and the four Vice-Presidents. Throughout the year petitions are received, signed by the requisite number of Corporate Members, endorsing some outstanding member of the Society for election as an Honorary Member. These petitions are placed before this committee, and it in turn, bearing in mind the limitation of five which may be elected in any one year, makes choice of those to be placed before the Board for consideration. The names thus selected were passed for later letter-ballot by the Board.

During the afternoon session each committee advisory to the Board was called upon for a report, these being made by the respective Contact Members. By the nature of the circumstances, some of these reports were hardly more than a statement of continued attention to the respective assignments. In other instances oral reports of some length, telling of details or difficulties found in the problems which the committees were studying, and on which they seemed to be approaching conclusions, were presented.

NEW COMMITTEE ON PROFESSIONAL OBJECTIVES

About a year ago a petition was received by the Board asking for approval of the organization of a Division on Professional Activities. The Board has given long and special study to this petition, and at the Salt Lake meeting approved the organization of a Committee on Professional Objectives—a joint committee of Society members and Board members. The fundamental aim of this group will be to encourage the discussion of problems of a general professional nature, public relations, the social responsibilities of the engineer, and questions of this type. The Board realized that many of these problems were now being discussed by various existing committees and that the new group would thus function primarily as a coordinating—an "encouraging and prodding"—committee. Accordingly, after long discussion, the duties of the committee were very fully outlined. The report of the Special Committee as finally adopted appears in the Society Affairs section of this issue.

PUBLIC WORKS

The Board was in receipt of a report prepared by a selected personnel of the membership consisting of Daniel C. Walser, of Washington, D.C., J. Trueman Thompson, of Baltimore, Md., and S. W. Sawin, of Wilmington, Del., with Director Anderson as Contact Member, on the subject of the reorganization of the Federal Public Works Department. This committee made a most comprehensive study of the history of the proposed Department of Public Works, covering the period of perhaps two decades past, and recommended that the effort to obtain a single Department of Public Works seemed inadvisable for various reasons. On the other hand it recommended to the Board that the Board should endorse and support the formation of a reviewing and coordinating agency to function with respect to all existing operating agencies to bring about cooperation, to eliminate worthless projects, to place meritorious projects in their proper priority, and to act as a clearing house capable of making valuable recommendations to the federal Bureau of the Budget. The action of the Board

in this instance was to direct that the committee's report be published in CIVIL ENGINEERING, and that informed discussion be invited in order that the Board might be still further prepared as to what decision it might well make on this moot question. This report appears in the Society Affairs section of this issue.

NATIONAL WATER POLICY

Last November the Committee on National Water Policy sent to Headquarters a report in which Chairman Leroy Sherman of Chicago and several other members of the Society participated. That report recommended certain specific federal legislation. In some of its details, however, and in some of its recommended policies or legislation, it was not subscribed to fully by the Executive Committee and by the members of the Sanitary Engineering Division. Consequently it has received consideration by the Board at both Jacksonville and Salt Lake. In the meantime, congressional actions and other events have altered conditions, and the Board is now seeking, through a new committee of Board members established for that purpose, a rephrasing of the report. When and if this is accomplished, it is planned to spread the revised report in CIVIL ENGINEERING in order that comments by the Technical Divisions, the Local Sections, and individuals, may be made available to the Board.

THE BOARD OF DIRECTION IN SESSION AT SALT LAKE CITY

SOCIETY ACCOUNTING AND RETIREMENT ALLOWANCES

Under the chairmanship of Director Ayres a special committee has been studying the accounting practice of the Society and hopes to develop a new plan which will make it possible to determine more clearly and fully the cost of each of the many items of activity—services the Society renders its members. Similarly, another committee, under the leadership of Director Myers, has given careful attention to the obligations of the Society as regards retirement allowances for its Headquarters' staff—57 in number. It is realized that the present practice of the Board in granting allowances of various amounts on retirement cannot be continued, and steps must be taken to set up a more definite plan on a sound financial basis. A very complete report was received at Salt Lake and is to receive final action in October.

MEMBERSHIP QUALIFICATIONS

While the Society has grown in numbers as the years have passed, the standards of admission to the various grades of membership have also been developed and strengthened—there has been a constant tendency toward higher qualifications for admission or transfer.

Each year the Society has to handle some 1,600 applications for admission and transfer. In past years these have come before the Board sitting as a committee of the whole and, owing to their large number and the press of other business, have usually required a long and tedious night session. It was realized that many of the applications were clear-cut cases—the applicant was clearly and fully qualified for the grade of membership requested. At the same time there were other cases where additional information and full study were required if standards were to be maintained, and full consideration and justice be given to the applicant.

With a view to relieving the Board of a long consideration of clear-cut cases and permitting even more thorough attention to be given the doubtful ones, a new procedure was put into effect tentatively in January 1937. It has apparently been most successful in doing what was expected of it. In those cases where the applicant's endorsers and the local membership committee agree, and where the Board's Committee on Membership, after reviewing the applicant's record, concurs, the name is passed directly to the Board members for letter-ballot. Where there is disagreement, each case is carefully studied by the Board's committee and suitable action is recommended to the Board. All questionable cases thus come before a general meeting of the Board and are subject to full review in the light of the committee's recommendations. There have usually been 100 or more such special cases for each meeting, but as the procedure has developed, and the standards which the Board desires to maintain have become clarified, this number has been reduced by about half.

One of the vital problems lies in the distinction of "responsible charge," and particularly "responsible charge of *important* work," which is essential in the transfer from Junior to Associate Member and from Associate Member to Member. The Committee on Membership Qualifications has given much time and thought to clarifying these terms and, in particular, to reducing the number of reference forms and making this distinction more obvious. In addition to relying very strongly on the advice of the local membership committees, a new application form has been prepared which requires specific information from the applicant on this point. One of the last actions of the Board at Salt Lake was the approval of this form.

The Board adjourned about noon on Tuesday, July 19, to meet at 10 a.m., October 10, in Rochester, N.Y.

Experience in Driving and Testing Composite Piles

By HENRY D. DEWELL

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THIS is an account of the driving of 100,000 ft of composite pile. Settlement of previous foundations at the same site caused the engineers to give especially careful attention both to specifications and to construction methods; and the satisfactory service record of the new foundations shows that the job was well done. Towards the end of the article, valuable test data are presented on the strength of splices in composite piles. It is of interest to note that damage to a tenon during driving appeared to have very little effect on the bearing capacity of the completed pile.

ALLUVIAL soil of low bearing capacity characterizes the site of the pretreatment works of the Sacramento (Calif.) filtration plant. As settlement of foundations of the first units, completed in 1920, resulted in some serious structural difficulties, particular attention was given to securing adequate pile foundations for the plant addition that was begun in 1931. The results were most satisfactory; after five years of service (1933 to date), the reinforced concrete tanks and reservoirs of the addition show no settlement, no leakage, and no perceptible cracks. A description of these foundations, with pertinent notes on tests and construction methods, should therefore be of interest.

The pretreatment works are located near the confluence of the Sacramento and American rivers, in what was once the bed of the latter stream. In this area the ground-water level fluctuates during the year; the maximum variation is over 20 ft, following quite closely the water levels of the rivers. The lowest ground water on record is about 14 ft below the natural surface of the site.

In the course of soil investigations for the plant addition, 9 test wells were sunk and a number of test piles—both timber and precast reinforced concrete—were driven. One of the wooden test piles, with a length of 60 ft 6 in., a butt diameter of $14\frac{1}{2}$ in., and a point diameter of 9 in., was driven into the ground 60 ft 3 in. with 726 blows, and then pulled for examination. It was found to be unharmed, except for a slight brooming and the loss of a small chip, both at the point.

Four other piles were tested for load-bearing capacity. Each of three timber piles carried a load of slightly over 40 tons with no measurable settlement; similarly, a reinforced concrete pile carried a load of 62 tons without settlement. The loads were limited by the strength of the loading platforms and did not represent the ultimate capacities of the piles.

For the plant addition, special composite piles of cased-concrete and wood were selected in competition with piles of creosoted Douglas fir. They were constructed in accordance with the specifications of the consulting engineer, which incorporated those special features common to patented types. Each pile had a lower portion of untreated Douglas fir, driven to the elevation of permanent ground water (El. 0.00 city datum, about 14 ft below the ground surface), and an upper portion of galvanized, corrugated, sheet-steel casing, filled with concrete, extending to the bottom of the footing above. Before driving, the butt of each timber pile was trimmed to form a tenon 18 in. long, which was tightly wrapped with No. 9 gage galvanized wire, stapled in place. This tenon fitted into the socket of the cast-steel driving mandrel and, in the completed pile, became incased in the special mortar portion of the upper cased-concrete pile, thus forming the splice (Fig. 1).

The following description furnished by the contractor illustrates the sequence of construction operations he proposed:

"A core having a solid steel point is fitted into a heavy steel casing. The two are driven together into the ground until the bottom of the casing is well below the ground-water level. The core is removed from the casing and a wood pile having a wire-wound tenon is inserted. Using the core as a follower, the wood pile is driven through the casing until the head is below the ground-water level and the resistance to driving indicates a bearing value equal to the load shown on the plans and specifications. The core is removed and a corrugated metal shell containing a reinforced cage, and dogs to grip the pile head, is placed through the casing so that it will surround the tenon of the wood pile and extend to the ground surface. The metal shell may be filled with concrete at this point or after the withdrawal of the casing. The core is lowered into the casing until it contacts with the metal shell. It is then fixed in this position so that the shell cannot rise with the casing, which is now pulled out of the ground."

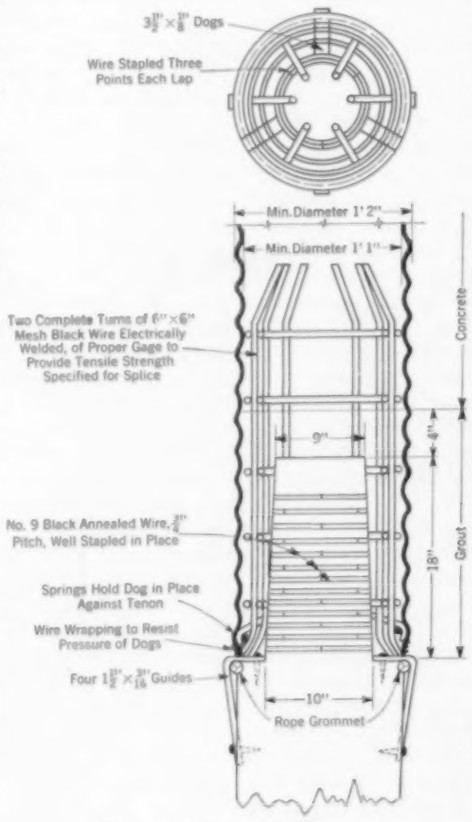

3½" × ⅜" Dogs
Wire Stapled Three Points Each Lap
Min. Diameter 1' 2"
Min. Diameter 1' 1"
Two Complete Turns of 6" × 6" Mesh Black Wire Electrically Welded, of Proper Gage to Provide Tensile Strength Specified for Splice
Concrete
9"
4"
No. 9 Black Annealed Wire, ¾" Pitch, Well Stapled in Place
18"
Grout
Springs Hold Dog in Place Against Tenon
Wire Wrapping to Resist Pressure of Dogs
Four 1½" × 3/16" Guides
10"
Rope Grommet

FIG. 1. DETAIL OF SPLICE

The following provisions of the consulting engineer's specifications were found to be of special importance; their reasonable enforcement had much to do with the satisfactory performance of the foundations.

1. Wooden Test Piles. Before ordering piles the contractor shall

furnish and drive [in certain specified locations] 14 test piles of untreated Douglas fir of lengths not less than 60 ft. Such test piles shall be driven to the requirement of depth and penetration specified. But this requirement for test piles shall not act to prevent the contractor from furnishing and driving at his own expense additional test piles, if in his opinion such additional test piles are necessary to enable him to properly determine the required length of piles for each footing, provided that this procedure is approved by the city engineer.

After such test piles have been driven to the depth required by the city engineer, they shall be cut off 6 in. below ground level and left in place. From the results of this test pile driving, taken in conjunction with the results of the test piles driven by the city, the contractor shall prepare a list showing number and lengths of timber piles necessary for the job, and the distribution of the various lengths to the individual pile clusters.

2. Required Penetration. All piles shall be driven to such a depth that the last 20 blows of a 5,000-lb ram of a single-acting hammer with a fall of 3 ft 6 in., when striking the unbroomed heads of the piles, shall not produce an average penetration greater than $^1/_4$ in., provided that the bottom of the pile shall be at an elevation not higher than −35 ft city datum, and provided that, if the bottom of the pile is diven to El. −45 ft city datum, or lower, the penetration as above specified may reach but not exceed $^1/_2$ in. per blow as averaged for the last 20 blows.

FIG. 2. EXPOSED SECTION OF SPLICE

The Four Splices Thus Examined Were Found to Be in Perfect Condition. In the One Shown Here, a Section of the Metal Shell Has Been Removed for Examination of the Concrete

3. Elevation of Top of Tenon. The top of the tenon of the wooden portions of composite piles shall be driven to an elevation not higher than zero, city datum.

4. Concrete Proportions. Concrete shall be mixed in the proportion of one sack of cement to $5^1/_4$ cu ft of fine and coarse aggregate, measured separately by loose volume in the damp condition as handled in the field.

5. Mortar Around Tenon. Special modifications of the mix as affecting the relation of fine aggregate to coarse aggregate shall be made for the concrete placed at the top and around the top of the wooden pile, all as may be directed by the city engineer.

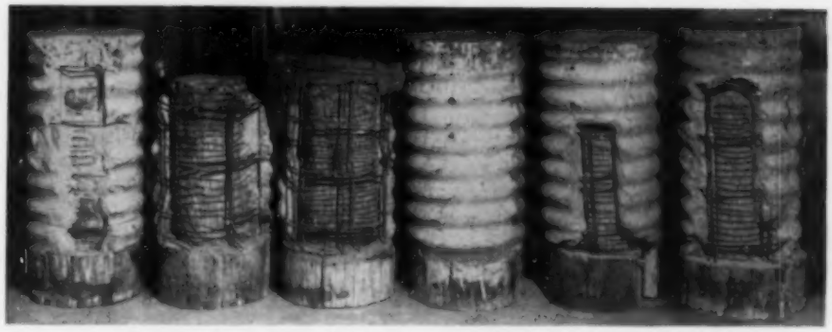


FIG. 3. THE COMPRESSION SPECIMENS AFTER TEST (ARRANGED IN ORDER; NO. 1 AT LEFT)

Specimens Have Been Partly Demolished for Purposes of Examination

6. Tamping Concrete. All concrete shall be placed in a manner that will permit thorough compacting and shall be worked into the form by means of rods. The contractor shall provide men for tamping and hammering it into place to the amount of at least one man to every 2 cu yd of concrete poured per hour. These men shall be in addition to those required for mixing, wheeling, etc.

7. Packing Earth Around Pile. If the diameter of the steel-encased concrete section is smaller than the maximum butt diameter of the lower wooden portion, . . . the contractor shall compact the earth around the upper portion to provide a tight fit satisfactory to the city engineer. Such packing shall be done by the use of water jet, or by the use of sand sluiced or tamped, or as may be determined necessary by the city engineer.

All timber piles were examined by a special inspector from an independent testing laboratory, and those not conforming to the specifications were rejected. Of importance in this inspection were density (as measured by rings per linear inch of radii of butt), butt diameter, and straightness; these last two factors were particularly important because the wooden piles were driven inside steel shells.

CONSTRUCTION PROBLEMS

It was found that construction conditions necessitated modification of a number of the contractor's proposed methods of framing, driving, and concrete pouring, and that the ideal conditions pictured in his description of driving operations were not realized.

The tenons of the wooden piles were first formed with axes, with unsatisfactory results. The tenons were not of circular cross-section, their length was variable, and the surface of the shoulders was uneven. Thus, in driving, the steel driving mandrel did not bear equally on the top of the tenon and on the shoulder at the bottom of the tenon. The contractor was therefore required to use a saw in cutting the shoulder, and to frame both shoulder and tenon accurately to the dimensions of the driving shoe. Thereafter, all piles were subject to inspection and approval after framing and before driving.

Some difficulty was found in convincing the contractor's superintendent that the specified final penetration of $^1/_4$ in. when using a 5,000-lb ram with a fall of 3 ft 6 in. and striking the unbroomed heads of the piles, would have to be decreased for the driving conditions of the job, because the 5,000-lb ram fell but 3 ft 0 in. and struck, not the head of the wooden pile, but the top of a steel driving mandrel some 30 ft long and weighing about

3,000 lb. A study indicated that the loss in efficiency due to the use of the mandrel and to the smaller drop of the ram was about 14 per cent. The estimated loss in energy due to the mandrel was obtained by solving a fundamental theoretical formula for pile driving, after insertion of the values of moduli of elasticity, lengths, and weights of timber pile and steel driving mandrel, and other constants. As a result of these computations, the specified penetrations of $^1/_4$ in. and $^1/_2$ in. were reduced to $^3/_{16}$ in. and $^1/_3$ in. respectively.

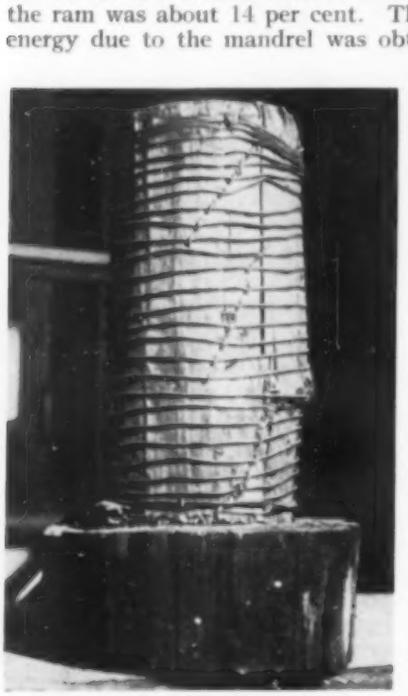


FIG. 4. SPECIMEN NO. 6 BEFORE TESTING, SHOWING DAMAGED CONDITION OF TENON
Such Damage Appeared to Have Little or No Effect on Bearing Capacity of Completed Pile

The first day's driving operations uncovered the difficulties usually found in starting a job. Wooden piles became wedged in the casing; ropes broke; the driving shoe filled with sticky clay after each driving of casing and had to be laboriously dug out. Water and mud were found in the casing after the wooden piles were driven to grade and were difficult to remove. Only one appliance for removing water, a steam ejector, had been brought on the job. Several times during the day both pile drivers simultaneously encountered difficulties with water and mud—and then the entire crew of one driver and the concrete gang would have to wait while the ejector was used on the other driver. Trouble also developed in coordinating the operations of concrete mixing with those of pile driving—the concrete would be mixed too long before it could be used and consequently would be difficult to work, or would have to be thrown away. In short, the day's operations were discouraging. However, these various difficulties were substantially overcome in the first few days.

A tendency was found for the upper or concrete portion of a completed pile to be shifted out of its vertical position by the driving of an adjacent pile; apparently the withdrawal of the casing left the concrete-filled shell without lateral support from the ground. This condition, anticipated in the specifications, was remedied by filling the cavity around the completed pile with earth, or by blocking the shell until the hole could be so filled.

The trouble with the filling of the driving shoe with mud continued throughout the whole job. The contractor tried to overcome this by placing thin sheet-steel plates about 2 ft by 2 ft square under the driving shoe before driving, with only partial success.

The attempted predetermination of the proper length of the wooden piles was often considerably in error, despite the exploration of the site with test wells and test piles. No satisfactory way was found to predetermine the proper length of wooden piles.

After a wooden pile had been driven to the proper elevation inside the steel casing, the driving core or mandrel was withdrawn and inspection made of the top of the wooden pile by means of reflected sunlight, or on cloudy days, with an automobile headlight attached to a long cord. Electric hand flashlights were found unsatisfactory. If the inspection indicated mud or water around the tenon of the pile, this was removed by means of the steam ejector. The corrugated steel shell was then dropped over the tenon to a seat on the shoulder of the pile, and the steel wire cage set in place. Then a predetermined amount of hand-mixed portland cement mortar was dumped by buckets around the tenon of the wooden pile to extend 4 in. above the top of the tenon. Next the shell was filled with concrete, tamped in place by means of a long rod. The buckets used for placing the mortar around the pile head soon became badly battered and had to be straightened at frequent intervals in order to make sure that the proper amount of mortar was being placed. The average 28-day ultimate compressive strength of the mortar grout was in excess of 5,000 lb per sq in., and that of the concrete about 4,500 lb per sq in.

When at times it became necessary to drive the top of the wood piles lower than El. 0, the elevation for which the steel casing had been driven, any trouble resulting from the wet sand wedging between the steel casing and the portion of the wooden pile which still remained within the casing, became accentuated. When such wedging of wet sand occurred, it was very difficult to determine the penetration of the wood pile, for the hammer blows were expended in forcing the wood pile through the steel driving shell and forcing both into the ground instead of the wood pile alone.

During the work, a question arose as to whether or not the corrugated steel shells of certain piles had been properly seated on the shoulders of the wood tenons. Consequently it was decided to excavate around a group of completed piles and examine them, even though such excavation required cribbing and pumping. The joints thus exposed were found to be satisfactory, as may be observed in Fig. 2.

One completed pile was test-loaded with a maximum of 40 tons. The resulting settlement was inappreciable.

During the driving, it was noted that when the shoulder of the mandrel first engaged the driving head of the steel casing—in other words, when the wooden pile and the driving casing began to penetrate the ground simultaneously—the rate of penetration decreased about two additional blows in 3 in. of penetration. Expressed another

LOAD TEST OF COMPOSITE PILE
There Was No Appreciable Settlement Under This Load

way, the ratio of blows required for 3-in. penetration just before and just after the moment when the casing and the pile were first being driven together, was about 9 to 11. Therefore, it was concluded that about 20 per cent additional energy was required to drive the steel shell and the wooden pile together, as against driving the wooden pile without the shell.

COMPRESSION AND BENDING TESTS OF SPLICES

A number of tests were made on the joints between the concrete and the wooden portion of the piles. Six of these were compressive tests to find the load-bearing value of the joints. These test joints were made to simulate the actual joints obtained in the field. The only exception was that the corrugated steel shells were removed before testing; for it was assumed that in the actual piles these shells would in time be rusted entirely away. A description of these tests is given in Table I, and the six test specimens are shown in Fig. 3. The photograph was

TABLE I. LABORATORY TESTS ON JOINTS OF COMPOSITE PILES

Test No.	Tenon Cut from	Shoulder Formed by	Condition of Head of Tenon	Compressive Strength, Lb per Sq In.		Breaking Load, in Tons
				Grout	Concrete	
1	Driven pile	Ax	Noticeably damaged in driving	3,018	994	92.5
2	Driven pile	Ax	Noticeably damaged in driving	2,861	2,067	88.4
3	Driven pile	Ax	Noticeably damaged in driving	3,487	2,327	127.5
4	Undriven pile	Saw	Good	3,698	2,247	*
5	Undriven pile	Saw†	Good	2,884	2,252	*
6	Driven pile	Ax	Considerably damaged‡	3,980	2,449	*

* Joint tested to capacity of testing machine (153.75 tons) without any apparent failure except vertical cracks in grout at top of tenon.

† In this test an attempt was made to simulate a possible field condition in which intrusion of wet sand in joint might prevent grout from setting on shoulder of tenon. Bottom of grouted section, for a height of 2 in. above shoulder, was filled with fine wet sand so that grout section would not touch shoulder.

‡ Head of tenon had been slightly rounded through excessive driving; tenon also considerably damaged in driving, with splitting of wood parallel with grain and crushing of wood fibers at point about 5½ in. above base of tenon on one side and around base of tenon on other side. This caused some eccentricity in axis of tenon when specimen was assembled.

taken just after the joints had been tested and partly demolished for purposes of examination. Note the damaged condition of the top of the tenons in Tests 2 and 3. In Fig. 4 is shown the section of wooden pile of Test 6 before the grouted section had been cast around it. The damage to the tenon from over-driving, resulting in splitting and crushing of the timber, is clearly shown.

The tests indicate that improper forming of the tenons, over-driving with resultant damage to tenons, and infiltration of wet sand and water resulting in a lessened length of grip of the grouted section on the tenon, had very little effect on the bearing capacity of the pile. Evidently the effect of the mortar and concrete cap around the tenon was to compensate for all defects in forming and driving the pile. All the joints behaved in a somewhat typical manner, in that they broke in the immediate vicinity of the top of the tenon. The ring of mortar surrounding the tenon appeared to carry the entire load. There was a definite bond between the grout and the tenon. The vertical wires of the reinforcing mesh were buldged at the point of break; indeed the zone of fracture in compression appeared to be bounded by the two circumferential wires which were spaced 6 in. apart, at the top of the tenon. Larger wires and a closer spacing would appear to have improved the joint. There was no deflection, nor was there any indication of cracking of the mortar grout or the concrete at the working load of piles, namely, 25 tons. The first failure, indicated by slight vertical cracks at the top of the tenon, occurred at about 65 tons.

One test was made of the flexural strength of a joint. The joint was tested in a horizontal position with a center load. The support on the concrete portion was 10 in. above the top of the tenon, and that on the wooden portion was 5 in. below the base of the tenon, giving a span of 36 in. The bearing point of the load was on the grouted section, 8 in. below the top of the tenon.

The maximum center load was 26,520 lb. Assuming that the strength of the joint was represented by a cylinder of concrete 13 in. in diameter, and neglecting the wire reinforcement, the modulus of rupture was 1,100 lb per sq in. For the conditions of the test, the bending moment was about 20,000 lb-ft. The same moment would be produced on one of the actual piles by a horizontal force of 1,450 lb applied 14 ft above the top of the tenon—that is, at average ground level, neglecting any passive support of the ground.

VIEW OF PILE DRIVER RIG

Steel Casing in Final Position on Ground; Wooden Pile Inside Casing and Partly Driven; Driving Mandrel in Leads and About to Be Lowered Into Position, with Its Lower End Fitting Over Tenon of Pile

In conclusion, it may be emphasized again that these piles have carried their loads, which in some cases have probably reached a maximum of 35 tons, without any appreciable settlement. The structures supported by them, consisting of reinforced concrete tanks and reservoirs, show no sign of leakage and no perceptible cracks after five years of service. The composite piles averaged 53.8 ft in length, and there is a total of about 100,000 lin ft of them in the foundations. They were furnished in place for a contract price of $0.70 per lin ft.

The work was under the direction of James S. Dean, city manager; Fred J. Klaus, city engineer; R. E. Mittelstaedt, superintendent of the Division of Water and Sewers; and Carl M. Hoskinson, M. Am. Soc. C.E., chief engineer of the Division of Water and Sewers. The writer acted as consulting structural engineer. The Western Foundation Company was the contractor.

ESTHETIC DESIGN CHARACTERIZES DENVER'S NEW SEWAGE-TREATMENT PLANT
All Buildings Have Been Designed to Harmonize, and Liberal Use Has Been Made of Tile for Decorative Effects. Attention Has Also Been Given to Landscaping and Yard Lighting

Sewage Disposal at Denver, Colo.

By E. B. BLACK
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, KANSAS CITY, MO.

THE sewage-treatment plant at Denver, Colo., which went into operation in January 1938, is of particular interest to engineers in the arid sections of the country because of its close relation to irrigation.

The State of Colorado holds the legal title to the sanitary sewage of Denver, and when sewage is discharged into the South Platte River, it may be appropriated in the same manner as the natural flow of the river. The entire flow of the South Platte below Denver is appropriated for irrigation, and approximately 130,000 acres of land are irrigated by diversions from the river within 25 miles of that city. About 18,500 acres of this area are devoted to intensive truck gardening, and it is evident that the use of sewage-laden water for irrigating such lands constitutes a definite health menace.

During the period for which records are available, Denver sanitary sewage has averaged 21.5 per cent of the total flow of the South Platte inclusive of floods, and on individual days the sewage has constituted more than 97 per cent of the flow. The concentration of sewage has caused serious nuisances along the river and in irrigation canals leading from it, and has resulted in the formation of sludge banks in the river bed and the upper reaches of the canals.

The Colorado State Board of Health has fixed the limit of allowable pollution of the river below Denver at 40 ppm, as measured by 5-day B.O.D. A minimum river flow of 4,500 cu ft per sec would be required to meet this standard by dilution, but such a flow has occurred on only 28 days during a 46-year period of record. Hence it was necessary to provide other facilities for treatment of the sewage. The new plant has been designed for preliminary treatment only—to remove suspended solids to such an extent that subsequent settling in the river and canals will be eliminated; and, when supplemented either by dilution or chemical precipitation or both, to produce an effluent coming well within the allowable pollution.

In addition to the flow of the river, an average of 12,000 acre-ft of diluting water will be required annually as long as the sewage is given primary treatment only, and construction is now under way on the Williams Fork Diversion Project, which is designed to divert water for this purpose from the west slope of the continental divide. This project involves a number of concrete diversion dams on the small streams that join to form Williams Fork of the Grand River; 19,000 ft of welded steel pipe conduit; and a tunnel which will take the water under the divide, to the east slope where, by way of Clear Creek and the White Cap Canal, it will reach the South Platte River near the sewage-treatment works. A storage dam will also be constructed on the Williams Fork to store runoff for irrigation purposes on the west slope in lieu of the water diverted through the tunnel.

Denver is sewered on the separate plan, and the sanitary sewer system serves 85 per cent of the population and practically all of the developed property within the city limits, as well as some suburban territory. About 270,000 persons are now served, and by 1948 the connected population should approximate 370,000.

The treatment plant (Fig. 1) is located on an irregular site of approximately 38 acres on the west bank of the South Platte River, just inside the north city limits. Equipment has been provided for the following major treatment processes: screening, grit removal, coagulation with chemicals, pre-aeration and mixing, sedimentation, mechanical filtration, sludge digestion, and sludge disposal by air drying. Design is based on an average flow of 54 mgd, or 170 gal per capita from a contributing population of 317,000.

Approximately 95 per cent of the sewage is delivered to the plant site by gravity at an elevation that permits gravity plant operation. Sewage originating east of the Platte River is collected in an intercepting sewer and delivered through a river crossing consisting of two self-supporting spans, each 105 ft in length, of steel pipe 78 in. in diameter, designed with welded stiffener rings and increased wall thickness at points of support. Sewage originating on the west side of the river is delivered by an intercepting

IN its first 25 miles below Denver, the South Platte is used for irrigating 130,000 acres of land; yet at times its flow has consisted almost entirely of sewage from the city of Denver. To eliminate the nuisance and the definite health menace of this condition, Denver has just built a 54-mgd sewage-treatment plant and is still at work on a project that will bring additional water for dilution purposes from the other side of the continental divide. This article, describing the treatment plant and giving data on its first few months of routine operation, is abridged from a paper on the program of the Sanitary Engineering Division at the 1938 Annual Convention.

sewer to a junction structure at the west end of the river crossing, and sewage from the low-lying Globeville district is pumped to the same point. The entire gravity flow may be by-passed to the river through

SETTLING BASINS AND SLUDGE PUMP HOUSE; MAGNETITE FILTERS IN THE BACKGROUND

motor-operated sluice gates in the junction structure, and the pressure line from the Globeville district is equipped with a blowoff to the river.

Sewage leaves the junction structure through a concrete pressure line, 72 in. in diameter, and passes through a venturi meter to an uptake shaft at the intake end of the screen channels. The venturi meter is electrically connected to indicating and recording devices in the chemical building and the administration building.

In the screen house the sewage flows in three 5 by 6-ft channels, in each of which is a mechanically cleaned bar screen. A shredder is installed at each screen, and screenings are shredded and returned to the sewage flow.

The screened sewage passes through an overflow chamber—fitted with longitudinal weirs set to automatically by-pass flows in excess of 90 mgd—into two grit-removal tanks equipped with mechanical cleaning devices of the straight-line type. Grit from the tanks is deposited in hoppers from which it is hauled by truck and used as fill.

From the grit removal tanks the sewage goes to an aeration tank 140 ft long with two compartments, or passes, each 20 ft wide and 16 ft deep. Each compartment is equipped with mechanical skimmers, and the tank provides a 15-min detention period. The sewage is aerated by compressed air admitted through porous plates set in the bottom of each tank, along the sides. When required, coagulant is to be added to the sewage in a flume between the grit-removal tanks and the aeration basin. The aerated and chemically dosed sewage passes through each of two compartments of the mixing basin, 140 ft long, 16 ft wide, and 16 ft deep, equipped with paddle-type mechanical agitators and providing a 15-min mixing period.

From the mixing basins the sewage passes through a flume to a central feed well serving the four settling basins. These basins have central feed and peripheral overflow, and provide a 2-hour average detention period, with a settling rate of 877 gal per sq ft per day. Each of the basins is equipped with clarifiers.

After settling, sewage flow in excess of 80 mgd will be by-passed to the river, but the sewage up to that amount is filtered through six magnetite filter units with a total filter area of 14,000 sq ft. The sand has an effective size of 0.5 mm, and the beds are 3 in. thick. The normal filtration rate is 2.68 gal per sq ft per min, and the maximum rate will be 4 gal per sq ft per min. Each of the filter units is equipped with a solenoid-operated sand-washing machine which travels the length of the bed, approximately 172 ft, and picks up and washes a strip of sand 13 ft long (the width of the filter) and 1 ft wide, without interfering with the operation of the filter. Filtered sewage is used for washing, and the wash water is returned to the aeration tank for retreatment.

SLUDGE DIGESTION AND DISPOSAL

Sludge from the settling basins is pumped to the four sludge digesters. These tanks have a combined capacity of 681,000 cu ft, or about 2 cu ft per capita, inclusive of equivalent industrial load. Three of them are equipped with floating covers of the Downes type, and the skirt of the cover of the fourth tank is extended downward to provide for the storage of 30,000 cu ft of gas. The temperature in the tanks is controlled by the circulation of hot water from boilers fired with sludge gas. The space between the digesters is housed in and provides room on two floors for the boilers, auxiliary equipment, and pipeline systems for handling raw and digested sludge, gas, and supernatant liquor. Scum from the aeration and settling tanks is delivered by gravity to a sump in this

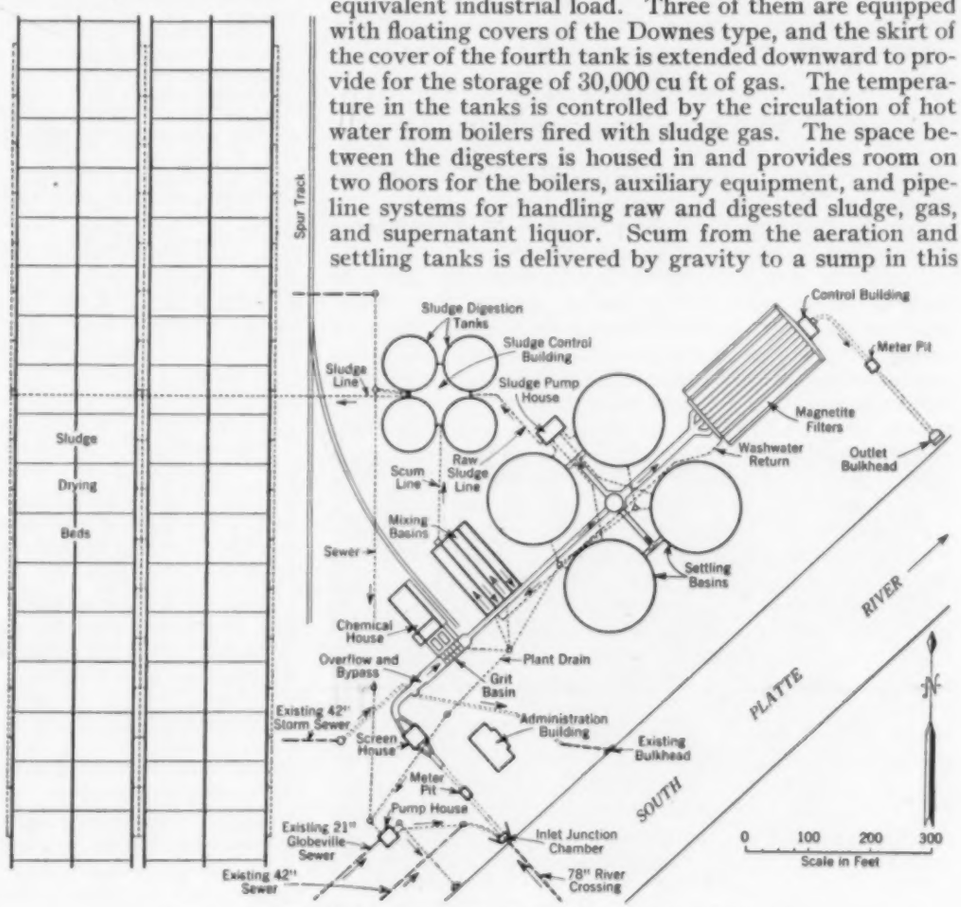
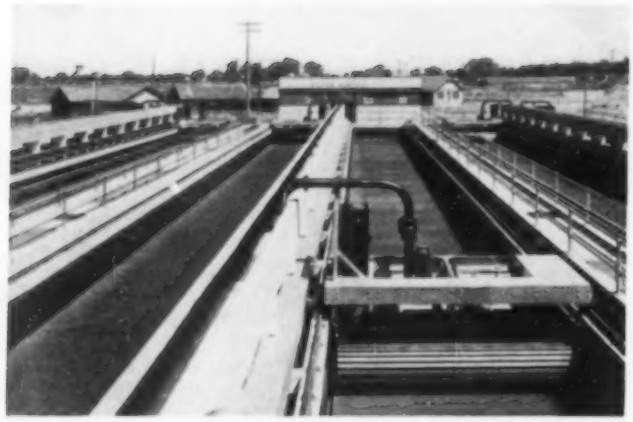


FIG. 1. GENERAL LAYOUT OF DENVER SEWAGE-TREATMENT PLANT



EACH OF THE MAGNETITE FILTER UNITS IS EQUIPPED WITH A SOLENOID-OPERATED SAND-WASHING MACHINE

sludge-control building and is pumped into the digesters.

Under normal operation, three of the tanks will receive raw sludge, and the fourth will be used for storing digested sludge and supernatant liquor. The latter is then delivered by gravity to the Globeville sewers and returned by the pumping station to the junction structure at the inlet to the treatment plant.

Digested sludge is air dried on undrained sand beds having a net area of 12.5 acres. Each of the 68 beds is 80 by 100 ft in plan. Sludge is run onto the beds by gravity through a system of valve-controlled conduits, and dried sludge is shoveled from the bed by hand to motor-driven belt conveyors and deposited at the edge of the beds or directly in trucks. Two of these conveyors are required, one to serve each area of 34 beds. Power for operating them is taken from overhead trolleys.

CHEMICALS MANUFACTURED AT PLANT

Because of the distance from manufacturing centers and the consequent cost of freight on chemicals, commercial forms of ferric chloride and sulfate are too expensive for use in the chemical treatment. Hence provision has been made at the plant for the manufacture of chlorinated copperas and ferric chloride.

Four steel bins are provided for the storage of 200 tons each of pulverized quicklime and copperas. The chemicals are transferred from railroad cars to the bins by means of pneumatic equipment. Chlorine will be received either in tank cars or in one-ton containers, and will be removed as a liquid from the car or container to heated evaporators from which gas will be obtained for the chlorinators. Four solution-type chlorinators, each with a capacity of 2,000 lb per day, discharge to a header which leads chlorine to the oxidizing and reaction tanks.

Ferric chloride will be manufactured in four concrete reaction tanks with false bottoms of concrete blocks. Small pieces of scrap iron will be placed in the tanks, and a solution of chlorine will be passed upward through the false bottoms to the draw-off lines 15 ft above. Three of these tanks will operate in parallel to provide a 90-min reaction period, and the fourth will be used as a standby. Provision is made to oxidize the ferrous product of these tanks with chlorine. Ferric chloride produced by this method cannot be stored, and in order to meet the changing plant requirements necessitated by the rapid changes in the strength and quantity of the raw sewage, dry feed machines have been installed to feed copperas into the oxidizing tank, and to feed additional chlorine to make up the required amount of ferric iron.

Routine operation of the plant started early in May 1938, and while two months is much too brief a period from which to draw conclusions as to just what results may be accomplished, it is significant that during this period, while operating without chemicals, the plant reduced the average B.O.D. in the raw sewage from a total of 140 ppm to 63 ppm in May, and from a total of 137 ppm to 51 ppm in June. The Platte River below the plant showed an average of 6 ppm of B.O.D. in May and of 22 ppm of B.O.D. in June. These results are well below the standard of 40 ppm of B.O.D. set by the state board of health. Operating data are presented in Table I.

TABLE I. OPERATING DATA FOR MAY AND JUNE 1938

	MAY	JUNE
Average daily sewage flow (in millions of gallons)	37.1	37.8
Maximum rate of flow, mgd	76	78
Minimum rate of flow, mgd	23	18
Cubic feet of grit (in millions of gallons)	2.5	2.1
Clarifier average settling rate, gallons per sq ft per day	603	615
Clarifier average detention period, in hours	2.91	2.86
Average filtering rate, gallons per sq ft per min	1.77	1.81
Kw hr power used (in millions of gallons) not including transformer losses	34.3	34.7
Suspended solids, average ppm		
Raw sewage	159	178
Settled sewage	45	44
Filtered sewage	28	27
Average 5-day B.O.D., ppm		
Raw sewage	140	137
Settled sewage	74	57
Filtered sewage	63	51
Platte River above plant	3	3
Platte River below plant	6	22*
Average per cent removal of suspended solids		
By clarifiers	72.0	75.5
By filters	10.7	9.5
By plant over-all	82.7	85.0
Average per cent removal of B.O.D.		
By clarifiers	47.2	58.3
By filters	7.8	4.4
By plant over-all	55.0	62.7
Raw sludge		
Per cent of solids	6.2	5.9
Per cent of volatile matter in solids	70	70
Digested sludge		
Per cent of solids	5.1	5.7
Per cent of volatile matter in solids	53	50

** River stages lower in June than in May*

The Williams Fork diversion project, now under construction, and the main sewer extensions and the Platte River sewer crossing already completed, were designed and their construction was supervised by the office of A. K. Vickery, M. Am. Soc. C.E., chief engineer for the city and county of Denver. The collection conduits and small diversion dams in connection with the Williams Fork project are being built under contract by the Ed. H. Honnen Construction Company of Colorado Springs, Colo., and the diversion tunnel is being built under contract by Broderick and Gordon of Denver.

The sewage-treatment plant was designed by Black and Veatch, and its construction was supervised jointly by Mr. Vickery and Black and Veatch. The contractor was Peter Keiwit and Sons Company of Omaha. The Public Works Administration participated in the construction of all these projects to the extent of 45 per cent grants, with the exception of the main sewer extensions and the river crossing, which were constructed by the Works Progress Administration. The costs of the various features are as follows:

Sewage-treatment plant, including construction, land, clearing and grading, engineering, legal and administrative costs, except interest		$1,477,769
Main sewer extensions, including river crossing		153,213*
Williams Fork diversion project		
Tunnel	$1,077,100†	
Collection conduits and diversion dams	303,400†	
Williams Fork Dam	398,300†	1,778,800†
Total		$3,409,782

** City's share only; WPA costs not included*
† Estimated; project still under construction

The Delaware Water Supply System of the City of New York

By ROGER W. ARMSTRONG
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
DEPARTMENT ENGINEER, BOARD OF WATER SUPPLY, NEW YORK, N.Y.

NEARY a billion gallons of water a day are currently needed to meet the demands of New York City—and the usage is steadily increasing. With the Croton and Catskill supplies developed to their limits, the city is now at work on a $272,000,000 project that will tap the Delaware River watershed and eventually add 540 mgd to the supply. The principal features of the work are 117 miles of tunnel, 37 shafts from 300 to 1,550 ft deep, and three large dams. In this article Mr. Armstrong describes the general project, reviews its history, and reports on its present status.

THE necessity of providing additional water for New York City was recognized as early as 1921. At that time the city's supply was derived from the Croton and Ridgewood systems, the Catskill system (which had not then reached its full development), a small municipal system on Staten Island, and several private water companies. The average daily use of water, which for the year 1921 was 732 million gallons, had been increasing for ten years at a rate which if maintained or increased during the next decade would bring the consumption dangerously close to the estimated dependable yield of the existing works. Consequently the Board of Water Supply was requested to undertake studies to ascertain the most desirable and best sources for an additional supply.

An exhaustive investigation of all available sources indicated that a plan which included the diversion of water from the Delaware River basin would be most economical in construction and operation, as well as furnish the best quality of water for domestic use. The adoption of such a plan, estimated to cost $272,587,000, was recommended by the Board.

INTERSTATE COMPLICATIONS CAUSE DELAYS

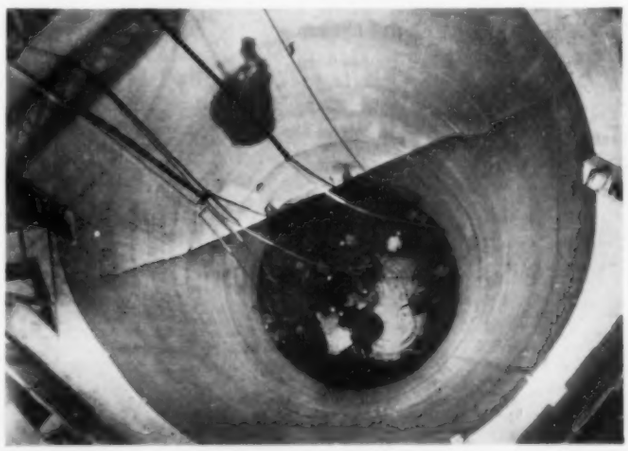
The Delaware River originates in New York State and has a drainage area in that state of 2,389 sq miles. In its course to tidewater, however, it forms the boundary line between New York and Pennsylvania and between New Jersey and Pennsylvania, and therefore it was probable that its use without the consent of the other states would be contested. Two attempts were made to allocate its waters by treaty between the states of New York, Pennsylvania, and New Jersey. Commissions appointed by the governors of these states made a thorough study of the legal and engineering questions involved and submitted for approval compacts setting forth equitable terms for diversion by the several states. Both these compacts were ratified by the New York State legislature but no action was taken by the other two legislatures.

Believing that its right to divert water from the Delaware River watershed could not be denied, the City of New York thereupon determined to proceed with a plan which included the diversion of 600 mgd from tributaries of the Delaware River. The State of New Jersey promptly brought suit in the U. S. Supreme Court to enjoin this plan and the State of Pennsylvania was subsequently permitted to intervene. Following a lengthy trial before a master, a decree was entered on May 25, 1931, which recognized the right of the city to divert not over 440 mgd from the Delaware watershed. The decree also provided that at any time when the flow of the Delaware River at Port Jervis, N.Y., or Trenton, N.J., falls below 0.50 cu ft per sec per sq mile of the drainage area above Port Jervis or Trenton, as the case may be, the city shall release from its impounding reservoirs water to restore this flow but shall not be required to release an amount exceeding 0.66 cu ft per sec per sq mile of the area from which water is diverted.

Work was started immediately on the preparation of plans and the acquisition of real estate. However, in 1932, when the first contracts were practically ready to be let, the finances of the city would not permit the necessary expenditure. Hence the beginning of construction work was deferred until 1936, when funds became available.

Meanwhile the necessity of providing additional water for the city was becoming more and more urgent. From 1921 to 1930 consumption increased yearly at an average rate of 30.5 mgd. The average consumption in 1930 was 1,006.8 mgd, very little below the estimated safe yield of the existing supply. During the next six years there was a slight decrease, attributed in part to the reduction in industrial use due to the business depression and in part to the reduction in domestic use resulting from the combining of families and the vacating of many apartments and residences. During these years also, the Department of Water Supply, Gas, and Electricity, in an energetic campaign to reduce waste from mains and house fixtures, was successful in stopping leakage and waste estimated at over 100 mgd. With the resumption of activity in industry, the average daily consumption increased noticeably and the necessity for pushing the construction work was accentuated.

The Delaware project, as approved by the city and state authorities, proposed the diversion of water from the East Branch of the Delaware River and the Neversink River, both tributaries of the Delaware River, and from Rondout Creek, a tributary to the Hudson River



SHAFT 4 UNDER CONSTRUCTION

LOOKING TOWARD SHAFT 7 FROM THE WORKING FACE OF THE TUNNEL
At This Point the Aqueduct Will Be 765 Ft Below the Surface of the Ground

(Fig. 1). All these streams have their sources in the higher Catskills, a region of high rainfall and runoff. Their watersheds adjoin those of the Esopus and Schoharie creeks, the sources of the present Catskill supply, and are similar in character, largely wooded and sparsely populated. A considerable portion of the watersheds lies within the Catskill Mountain State Park. Sites are available on each of the streams for storage reservoirs of ample capacity to regulate their flows. With the storage to be provided above the Lackawack Dam, the estimated safe yield of Rondout Creek is 100 mgd. The proposed drafts for the city's use from the Neversink River and the East Branch of the Delaware are 70 mgd and 370 mgd, respectively, but the volumes of storage proposed will develop yields in excess of these quantities sufficient to supply the water required for releases during periods of dry flow.

The Delaware supply will be developed in two stages, the first including the Rondout Creek and Neversink River, and the second the East Branch of the Delaware River. A third stage, to include the Little Delaware, Willowemoc Creek, and Beaver Kill, with a combined yield of about 160 mgd, is contemplated but cannot be included unless permission is granted by the U. S. Supreme Court to divert the additional water.

GENERAL FEATURES OF THE PROJECT

All the water of the Delaware supply will pass through the Rondout Reservoir (Fig. 1), the drafts from the Neversink and East Branch developments being delivered to it through tunnels about 6 and 26 miles long, respectively, operating at the hydraulic gradient or under slight pressure. The aqueduct from Rondout Reservoir to the city will be a pressure tunnel, the alinement of which provides connections with the existing water systems of the city at the West Branch Reservoir of the Croton system and at Kensico Reservoir of the Catskill system. Water from the Delaware system will normally pass through both these reservoirs. A further connection is proposed, whereby Delaware water can be delivered to the Catskill aqueduct at the point where the two aqueducts intersect, and facilities for introducing Croton water into the Delaware aqueduct will be provided at two convenient locations within the Croton watershed. Chlorinating plants will be installed in the outlet works of the Rondout, West Branch, and Kensico reservoirs; a coagulating plant for the removal of turbidity will be constructed in connection with the influent works at Kensico Reservoir; and an aerator will be constructed at the Kensico effluent works. About two miles west of Kensico Reservoir a chamber will be constructed for connections to possible future filtration works. (No filtration is contemplated at present.) Delivery of Delaware water to the city distribution system will be from Hill View Reservoir, the distributing reservoir of the Catskill supply, through the two existing delivery tunnels.

At the three dam sites, the valley formations are similar with respect to both surface configuration and configuration of the rock gorge beneath the valley floor. The dams will all be of earth embankment with concrete cutoff walls extending into bedrock. The areas to be flooded are mainly farms and woodland, though several small villages will be inundated. Highways low in the valleys will be relocated above the flow lines, and a new location will be required for the Delaware and Northern railroad in the valley of the East Branch of the Delaware.

The pressure tunnel between Rondout Reservoir and the city (Fig. 2) will be deep in the rock, circular in section, and lined with concrete. It will consist of three principal sections; the Rondout–West Branch tunnel 45 miles long and 13½ ft in diameter, delivering water from Rondout Reservoir into the West Branch Reservoir of the Croton system; the West Branch–Kensico tunnel, 22 miles long and 15 ft in diameter, delivering Delaware water combined with some Croton water into Kensico Reservoir; and the Kensico–Hill View tunnel 14 miles long and 19½ ft in diameter, delivering the combined waters of the Delaware, Croton, and Catskill systems to Hill View Reservoir and to the city. In addition, bypass tunnels 15 ft in diameter will be constructed between the influent and effluent works of both the West Branch and Kensico reservoirs.

All these tunnels will be constructed through shafts, at 26 locations from 1.8 to 5.2 miles apart. To avoid placing regulating valves under high pressure or in inaccessible locations, double shafts are provided at the inlet and outlet of West Branch Reservoir, at the inlet and outlet of Kensico Reservoir, and at the filter connection chamber, so that the actual number of shafts to be constructed is 31. Ten shafts are for construction purposes only and will be sealed after the tunnel is completed; one will be equipped with risers and control valves for admitting water to the Catskill aqueduct; 6 will have risers and connections which will be available for the delivery of water to communities along the line; 2 will be provided with facilities for introducing water from the Croton system and also for delivering water; and the remaining 12 will be waterway shafts. The shaft at the lowest point in each of the three main sections of the aqueduct will be provided with pumps, piping, and other equipment for unwatering the tunnels.

Most of the formations to be traversed by the Delaware aqueduct were encountered during the construction of the Catskill aqueduct, and the knowledge of their extent and character so gained has been used to great advantage both in determining a preliminary location for the aqueduct and in laying out the boring program and interpreting its results.

In general, the investigation of the aqueduct line consisted of test borings to tunnel grade at each shaft site and a sufficient number of borings along the tunnel line between shafts to determine the elevation and quality of bedrock. As a result of the information obtained from these subsurface investigations, deviations from straight lines between fixed surface points were made in the aqueduct location either to avoid zones where tunnel construction would be difficult and dangerous or to pass through such zones by the shortest pos ible route. At the prospective dam sites, sufficient borings were made

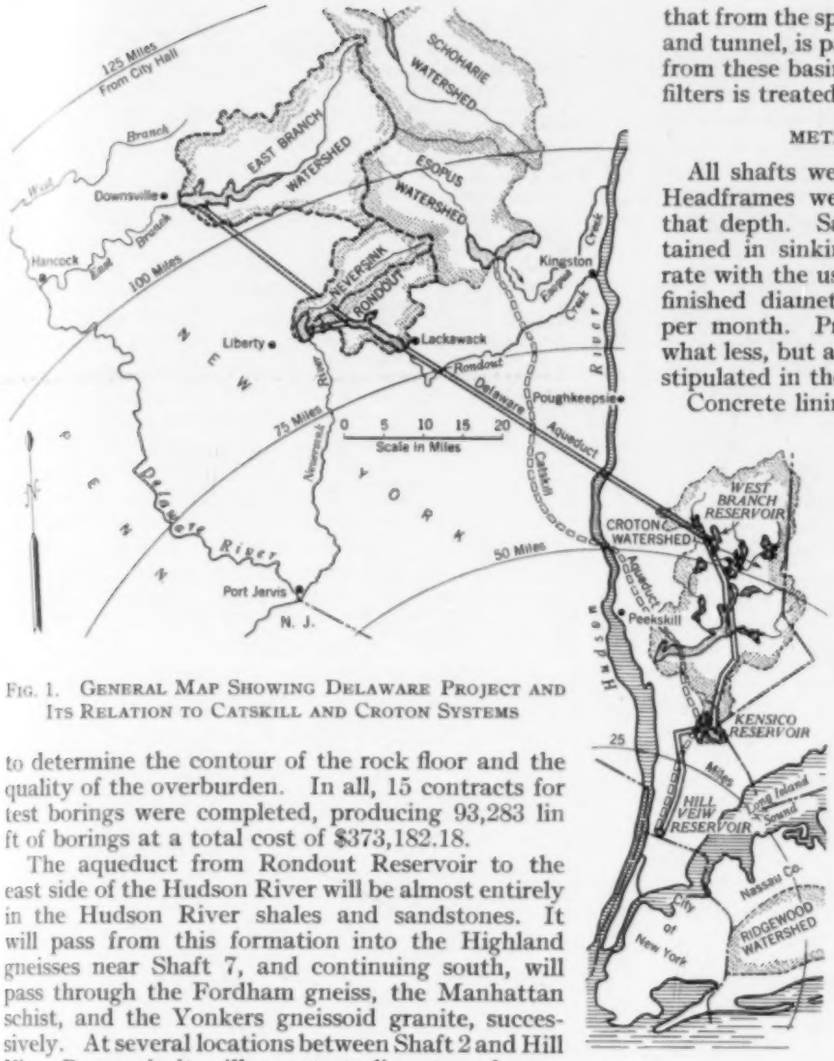


FIG. 1. GENERAL MAP SHOWING DELAWARE PROJECT AND ITS RELATION TO CATSKILL AND CROTON SYSTEMS

to determine the contour of the rock floor and the quality of the overburden. In all, 15 contracts for test borings were completed, producing 93,283 lin ft of borings at a total cost of $373,182.18.

The aqueduct from Rondout Reservoir to the east side of the Hudson River will be almost entirely in the Hudson River shales and sandstones. It will pass from this formation into the Highland gneisses near Shaft 7, and continuing south, will pass through the Fordham gneiss, the Manhattan schist, and the Yonkers gneissoid granite, successively. At several locations between Shaft 2 and Hill View Reservoir it will penetrate limestone formations for relatively short distances.

To speed construction, contracts were let for the deepest and most widely spaced shafts, together with those for the Kensico–Hill View tunnel, while the contracts for the dams and tunnels were still in preparation. In the contracts for shafts, a sufficient amount of tunnel excavation at the foot of each shaft was included to permit the contractors for the tunnel to install tunnel driving equipment immediately upon starting work. Other features incorporated in these contracts for the benefit of succeeding contractors included the installation of service pipes in the shaft linings, construction of booster pump chambers in the deep shafts, and of pump chambers and enlargements for plant purposes at the foot of the shafts; and the making of additional test borings at various places.

Since nearly all the shaft sites are in drainage areas from which the water is used for either domestic or recreational purposes, it is essential to prevent the pollution of streams while construction is in progress. Therefore, where no public sewers were available, the contracts included provisions for building sanitary works of sufficient capacity to take care of all sewage and drainage from the working areas during the construction of both shafts and tunnel. This involved generally the construction at each shaft of a sewerage system and a sewage disposal plant consisting of septic tank and intermittent sand filters. The surface drainage from the site, including that from the spoil bank area and the pumpage from shaft and tunnel, is passed through settling basins and the flow from these basins as well as the effluent from the sewage filters is treated with liquid chlorine.

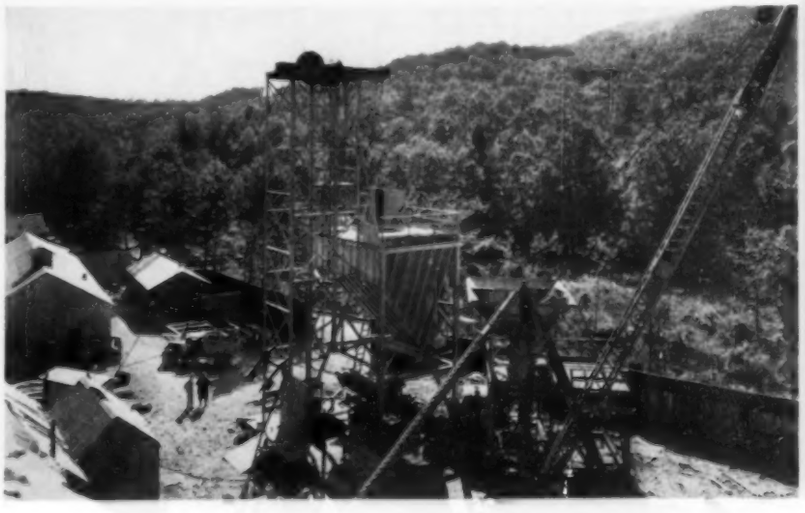
METHODS OF SHAFT CONSTRUCTION

All shafts were sunk by derricks for the first 100 ft. Headframes were then installed for excavation below that depth. Satisfactory rates of progress were maintained in sinking and lining the shafts. The average rate with the use of headframes for nine shafts having a finished diameter of 14 ft was approximately 100 ft per month. Progress on the larger shafts was somewhat less, but all shafts were completed within the times stipulated in the respective contracts.

Concrete linings were placed as excavation advanced, no more than 100 ft of unlined shaft being permitted at any time. Frequently, in poor rock, linings were placed at intervals of 25 ft or less. When water was encountered in sinking, it was immediately shut off, if possible, by drilling into the water-bearing seams and filling them with grout. Occasionally it was necessary to place concrete blankets in the bottom of excavations to confine the grout. When these methods were not successful, grouting through the permanent lining of the shaft was generally effective.

At most of the shaft sites sound rock was at some depth below the original surface, and excavation through the overburden was accomplished by supporting the surrounding earth by concrete curb walls, by timber sheeting and bracing, by steel sheet piling and structural steel bracing, or by the use of concrete caissons, depending upon the depth to rock and on the amount of ground water. The caisson method was adopted for Shafts 18 uptake and 18 downtake, where the depths of earth were 38 ft and 56 ft, respectively. The caisson for the uptake shaft has an outside diameter of 37 ft and that for the downtake shaft, 34 ft 6 in. Although the contract provided for the use of compressed air, if necessary, these caissons were successfully sunk and sealed to rock in free air.

Construction work on the Rondout watershed was started under two contracts for work preliminary to the building of the Lackawack Dam (Fig. 1). Under the first, two pneumatic caissons for the cutoff wall of the dam were constructed and sunk in the deepest part of the valley, in order to investigate the subsurface conditions and demonstrate the feasibility of building a cutoff wall



TYPICAL LAYOUT OF PLANT FOR SHAFT CONSTRUCTION

by this method. The caissons are 38 ft long and 15 ft wide and were sunk about 175 ft below the original surface. Since the success or failure of this method of constructing the cutoff wall depended on the air pressure needed in sinking the caissons, every effort was made to lower the ground-water level within the working area as much as possible. Each caisson was equipped with a pumping plant (in a chamber just above the working chamber) and in addition large wells equipped with deep-well pumps were sunk outside the caissons. Very little pumping was found necessary to keep the ground water down to a level at which it interfered very little with the caisson sinking. The greatest volume appeared to be in an artesian flow at the top of the rock and this was largely removed by pumping from the deep wells and from the caisson in which excavation was not being done at the time. No air pressures of more than 33 lb per sq in. were required, and the greater part of the sinking was accomplished in free air. The caissons were carried into the rock a depth of about 10 ft and sealed in that position. Permanent intakes for the pump suctions were provided in the seals, and pumping from the caissons has been continuous since their completion in order to keep the ground water at a minimum elevation and thus facilitate the sinking of the remaining caissons.

The second reservoir contract is for the control of the flow of Rondout Creek during construction of Lackawack Dam. It provides for a diversion tunnel around the southwest abutment of the dam, and a low diversion dam across the stream. The tunnel is about 2,400 ft long and 30 ft in finished diameter. Upon the completion of the main dam the upstream end of this tunnel will be sealed and the lower portion used as a discharge conduit from the reservoir spillway, with which it will be connected by an inclined shaft. The diversion dam will be an earth embankment with paved upstream slope and will eventually constitute the upstream toe of the main dam.

CONTRACTS AWARDED RECENTLY FOR MOST OF TUNNEL WORK

In addition to the contracts already described, six contracts have been awarded recently which include all but a small portion of the West Branch–Kensico tunnel; the entire Kensico–Hill View tunnel; the Kensico by-pass tunnel; and the influent, effluent, coagulating, and aerating works at the Kensico Reservoir.

Work completed or now under way is embodied in the following contracts:

Contract No.	Work Included	Date Awarded	Date Completed	Estimated Cost
306	Portion of West Branch–Kensico tunnel, Kensico by-pass tunnel, and portion of Kensico–Hill View tunnel	Aug. 4, 1938	.....	$21,333,333.33
307	Portion of Kensico–Hill View tunnel	May 9, 1938	.....	10,097,135.00
308	Portion of Kensico–Hill View tunnel	May 9, 1938	.....	11,971,885.00
322	Shafts 11 and 12 and portion of West Branch–Kensico tunnel	May 9, 1938	.....	10,829,530.00
323	Shafts 13 and 14 and portion of West Branch–Kensico tunnel	May 9, 1938	.....	10,810,166.50
324	Shafts 15 and 16 and portion of West Branch–Kensico tunnel	May 9, 1938	.....	10,985,200.00
332	Shafts 2, 2A, and 3	Jan. 22, 1937	.....	1,738,250.00
333	Shafts 4, 5, 5A, and 6	Mar. 12, 1937	.....	2,294,415.00
334	Shafts 7 to 10, inclusive	Mar. 12, 1937	.....	1,926,150.00
336	Shafts 17 to 23, inclusive	Jan. 22, 1937	June 21, 1938	3,947,542.32*
338	Two exploratory caissons for Lackawack Dam	June 15, 1937	May 11, 1938	543,059.37*
339	Diversion tunnel and cofferdam at Lackawack Dam	May 9, 1938	.....	2,869,390.00

* Actual cost of completed work. Other costs are computed from bid prices and approximate quantities.

It is expected that within the next few months contracts will be let for the Lackawack Dam, for the completion of the Rondout–West Branch tunnel, and for the short section at the north end of the West Branch–Kensico tunnel. These, with the contracts already in force, will provide for the construction of all the main structures between Rondout and Hill View reservoirs.

Construction of the Delaware water system is under the direction of the Board of Water Supply of the City of New York, George J. Gillespie, president, Henry Hesterberg and Rufus E. McGahen, commissioners. Walter E. Spear, M. Am. Soc. C.E., is chief engineer; Charles M. Clark, deputy chief engineer; and Thaddeus Merriman, Frank E. Winsor, and Silas H. Woodard, Members Am. Soc. C.E., consulting engineers. The design and preparation of contracts is under the direction of the writer as headquarters department engineer, and the construction work is in charge of James A. Guttridge, M. Am. Soc. C.E., Neil C. Holdredge, M. Am. Soc. C.E., and Harry R. Bouton, Assoc. M. Am. Soc. C.E., department engineers of the Watershed, Northern, and Eastern departments, respectively.

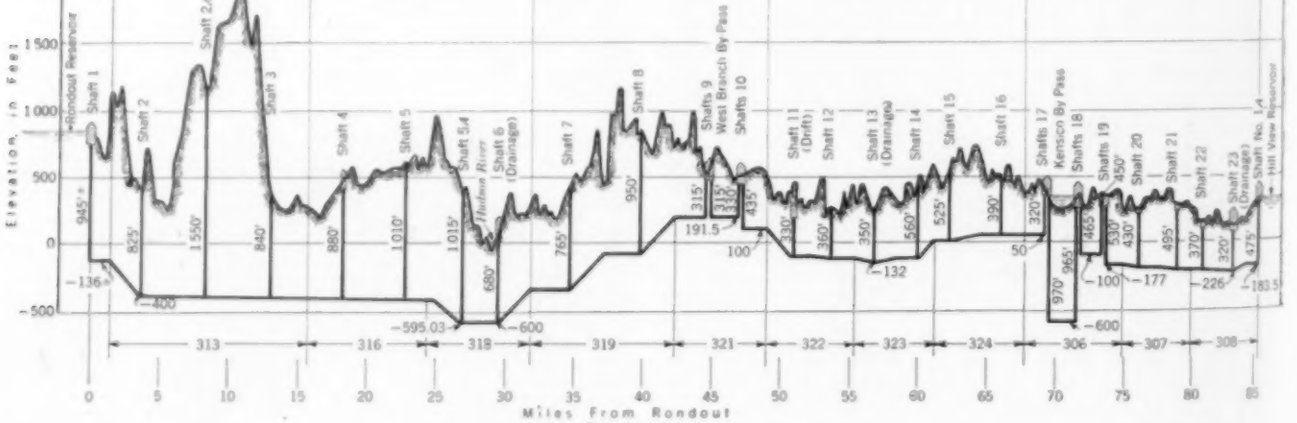


FIG. 2. PROFILE OF DELAWARE AQUEDUCT

Highway Transportation Since 1928

A Review of Developments and Trends, with a Look Toward the Future

By L. I. Hewes

Member American Society of Civil Engineers

Deputy Chief Engineer, U. S. Bureau of Public Roads, San Francisco, Calif.

In the past ten years, highway use has increased about 73 per cent. Highway mileage in the same decade has been extended at a slower pace. The era of rapid expansion of the highway net that began about 1916 is giving place to one of reconstruction to meet higher standards. At present, says Dr. Hewes, we are in a period of transition to many new concepts of highway design. The Highway Planning Survey, started in 1935 by the U. S. Bureau of Public Roads and now nearing completion, will throw much light on the present situation and on the course that future development should take. Dr. Hewes' original paper, here abridged, was presented before the Society's Annual Convention in July 1938, at Salt Lake City, Utah.

IN reviewing the development of highway transportation over the past decade, we should seek not only trends, but relations that remain constant. And we need to discuss also certain critical values of the variables that arise. Of course the general trend in highway transportation over the period from 1928 to 1938 is upward. There are more miles of improved road, more operating units, more traffic miles per unit, and consequently there is much more money involved. Another trend is the increase in the percentage of truck registration (shown by the line of figures at the top of Fig. 1).

Relations that always seem to hold true (invariants), are typified by the relation of the number of deaths and accidents to operating mileage—or say, per one million car-miles. The relation between the total registration of vehicles and the economic condition of the country for short periods is less fixed, but quite definite (Fig. 1). The invariably prompt recovery of traffic which accompanies business recovery is especially noticeable.

Examples of critical values of variables are afforded by such quantities as the limiting percentage of grade for trucks, the limiting safe speed for automobiles on curves, the density of traffic when the roads become congested, and fundamentally, the number of miles of road per state or county that the operating revenue can support.

A significant trend is revealed in Fig. 2, which shows the varying relation between total train-miles on Class I railroads and automobile registration for ten years. In Fig. 3 the number of persons per car is plotted for the past decade for the United States and for a group of 11 western states. Here is a trend that is approaching an invariant relationship, when a critical point will be reached.

From 1927 to 1937 truck registration rose about 47 per cent in the entire country, while in the same interval passenger vehicles increased about 26 per cent. Meanwhile, in the western states, trucks increased more than 77 per cent, and passenger cars 41 per cent. An invariable relation here is the excess of the rate of increase of trucks over that of passenger cars.

The Beginning of Development with Federal Aid

To better understand the past decade, it should be recalled that following the introductory period of highway improvement by state departments alone, there came, beginning in 1916, a period of development with federal aid. That period was most important. It provided nearly a quarter of a million miles of dustless roads. By the end of 1938 probably less than 15 per cent of the federal-aid system will remain without a dustless surface. Yet as this first stage of improvement has approached completion, the highway engineer has seen with increasing clearness the defects of the earlier work. By 1936 the inevitable reconstruction was well under way. For at least ten years, constantly increasing attention has been paid to the proper relation of the highway to traffic in volume, and to the operation of the individual car.

For traffic in volume, the engineer is now building traffic circles, clover-leaf intersections, wider traffic lanes, and separated lanes. In special places he is introducing artificial lighting. There is now definite recognition of the proper relation of so-called superhighways or freeways to other highways. The development of the freeway over a ten-year period has brought about the associated concept of the service road or adjoined side road with limited access. We now are in a period of transition in which many new concepts are being introduced. As fatalities increase we are giving greater attention to the elimination of railroad crossings at grade, and even of highway intersections at grade. Tunnels to reduce grade and curvature are becoming common in the western mountains. We are even designing profiles to reduce headlight glare where traffic volume is large. We recognize the limiting effect of

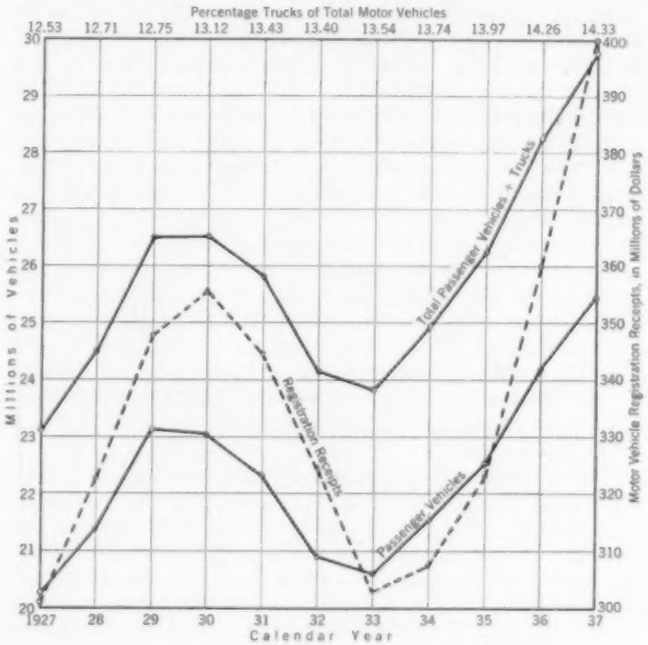

Percentage Trucks of Total Motor Vehicles
12.53 12.71 12.75 13.12 13.43 13.40 13.54 13.74 13.97 14.26 14.33
Millions of Vehicles
Motor Vehicle Registration Receipts, in Millions of Dollars
Total Passenger Vehicles + Trucks
Registration Receipts
Passenger Vehicles
1927 28 29 30 31 32 33 34 35 36 37
Calendar Year

Fig. 1. Motor Vehicle Registration, 1927 Through 1937, Total United States

steeper grades on truck traffic. By the same token, with the increased hill-climbing capacity of the passenger car, we are faced squarely with the fact that the cost of reducing grades is due largely to truck traffic.

A MIXING PLANT IN OPERATION IN COLORADO
"Development of Road-Mix and Plant-Mix Tops Is One of the Most Significant General Advances Since the Time of Macadam"

The establishment of a committee on design by the American Association of State Highway Officials is a most significant recent advance in the study of the relation of the highway to its traffic. Already this committee has made progress in the preliminary classification of highways with respect to traffic density and speed; to designed intersections and cross-sections; and especially to curvature and sight distance for designed speeds.

TECHNICAL IMPROVEMENTS SINCE 1927

Many details of highway design and construction that affect the operation of the individual car have improved since 1927. Among these, smoother riding surfaces, yet with non-skid texture, are conspicuous. The development of road-mix and plant-mix tops made with liquid asphalts and more finely graded local minerals has been truly remarkable—one of the most significant general advances since the time of Macadam. We have 24,000 miles of this oil-mix in the Far West alone, practically all built since 1927. More recently, practice has been improved by the use of full-width base courses and the abandonment of the old trench cross-section. We have learned to improve the surface of portland cement concrete with the delayed finish and final machine finish developed in Oregon and California. The dummy, or weakened plane joint, has eliminated transverse shrinkage cracks, and load-transfer devices at expansion joints have reduced corner cracks. We have improved the methods of controlling the concrete mixture, and have also learned how to cure the slab. The geometry of the design of highways has been given much study, and the best present standards are in theory quite satisfactory, both for traffic in volume and for the individual car. The use of transition curves or spirals is now established practice.

There are other important advances in highway construction, among which should be mentioned the classification of soils and the advance in soil stabilization theory. In certain areas, the use of stabilized soil bases has also become common practice. For paved jobs we are designing wider shoulders, and making them safe by surcharges of mineral and asphalt. The design of flatter cross-section slopes has advanced, and in some states the dangerous side borrow pit has been largely eliminated.

As regards highway appearance or roadside improvement, the progress in the last five years has been noteworthy. Rounding of cut slopes and elimination of scattered boulders are examples of requirements that have become standard. With federal-aid funds available to not less than 1 per cent of the total, the states are successfully carrying on additional work of landscaping, which becomes more and more effective with experience.

In this last ten-year period we have seen a marked increase in the volume and speed of traffic on the highways. The congestion that has resulted on certain highways, particularly in metropolitan areas, shows the need for the improved designs that here and there are becoming common. We have seen the demand for secondary-road improvement and the shifting in the source of highway funds from land taxes to traffic revenue. More and more miles of highway have been transferred from local to state jurisdiction. Thus the need for reliable information has become imperative.

VALUE OF THE HIGHWAY PLANNING SURVEY

The Highway Planning Survey, begun in 1935, is the outstanding feature of a decade of highway transport activity. This engineering survey, planned and executed by engineers, is now coming to completion in 44 states. It is a nation-wide operation that will furnish answers to many urgent questions—especially those regarding the economics of highway transport. One definite objective is the determination, for each state and county, of the number of miles of improved highway that can be supported economically. This survey will enable any political subdivision to determine scientifically the mileage that it can permanently own and operate by combining operating revenues with other funds, such as property taxes or loans.

If the survey is to attain these objectives, traffic density must be known on both a nation-wide and a local subdivision basis. Thus, sufficient continuous counts and sampling counts have been taken to determine traffic on every mile. Highways of all classes will be plotted on the most elaborate county unit maps ever made on a nation-wide basis. The financial structure and public taxation in each state has also been ascertained, with particular attention to the funds apportioned to highways. Special emphasis has been given to the origin and destination of all traffic. Likewise the relative use of highways by urban and rural traffic will be determined. A separate investigation of the probable life of various classes of highway construction has been made, and sufficient data will be collected to permit the setting up of a reliable mortality table for highway pavements.

With the total traffic known, as well as its origin and distribution on the roads, and with more precise data

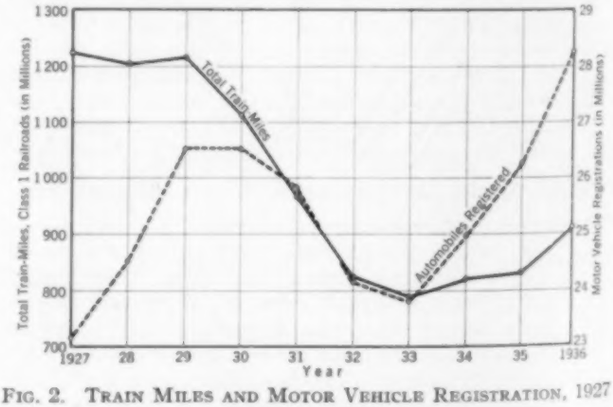


FIG. 2. TRAIN MILES AND MOTOR VEHICLE REGISTRATION, 1927 THROUGH 1936

as to cost of construction and maintenance and the life of various highway types, many hitherto bothersome questions can be answered with confidence. When the total mileage that can be owned and operated is determined, its proper location within states or counties can be readily determined from the state or county road maps.

Further time will be required for a full analysis of the data already collected in the Highway Planning Survey. Keeping this information up to date should become a continuing state function. Already very enlightening data are available. This survey is being carried on cooperatively by the Bureau of Public Roads and 46 state highway departments, under the immediate direction of H. S. Fairbank, chief of the Division of Information.

As an example of the information already developed, in 10 states a traffic analysis has been made of rural state highways that carry 1,000 or more vehicles daily. (The states are Alabama, Florida, Illinois, Iowa, Kansas, Michigan, Missouri, Ohio, Virginia, and Wisconsin.) This mileage is found to be definitely restricted. Its percentage of the total state mileage varies from 14.82 in Kansas to 41.05 in Illinois, and averages 24.5 per cent. The very small mileage of other than state highways that also carries 1,000 or more vehicles daily is most significant. Only in Virginia does this mileage exceed 1 per cent. In the other nine states the percentage varies from zero in Florida to 0.45 per cent in Michigan. These preliminary figures indicate that the problem of heavy traffic affects mainly the state highways. If, however, a traffic of 4,000 vehicles per day indicates the need for multiple-lane construction, then 10 states with a total of 860,000 miles have only 1,238 miles needing multiple lanes. In proportion, the whole United States now needs only about 5,000 miles of multiple-lane roads. On January 1, 1938, the country's reported total of four or more lane mileage was 3,452. In the previously mentioned group of 10 sample states there were 1,333 of these multiple-lane miles, which compares well with the 1,238 miles reporting 4,000 or more vehicles daily.

HIGHWAYS IN METROPOLITAN AREAS

Much of what has been said thus far applies largely to the state and federal-aid highway systems. It is pertinent next to consider highways in the metropolitan areas. The automobile has helped to "aerate" the cities and develop satellite towns. But population dispersion alone is not sufficient to ensure favorable patterns for metropolitan development. We must not cover the surrounding areas with too close a network of streets, and thus destroy the desirable features of the suburbs. It is going to be expensive properly to guide metropolitan traffic development, which is still in a plastic state.

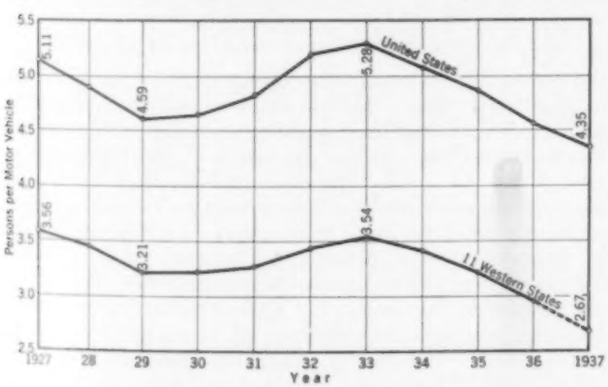


FIG. 3. POPULATION–MOTOR VEHICLE RATIO, 1927 THROUGH 1937

Some highways in metropolitan areas will have the dual purpose of serving internal traffic and traffic entering the areas from outside. Incoming traffic may be city bound or trans-city bound. Increasing experience indicates the high desirability of determining the ratios of such traffic fractions. We certainly should eliminate all unnecessary street traffic within the city. Consequently freeways or superhighways designed for trans-city traffic must not discharge that traffic unnecessarily into city streets. On the other hand, trans-city highways will be useful for certain fractions of city-destined traffic.

A RELOCATED FEDERAL-AID HIGHWAY IN CALIFORNIA
The Past Decade in Highway Development Has Been Characterized by Increasing Attention to Relocation and Reconstruction

The question of safety on the more important metropolitan boulevards has been given increasing attention, and emphasis has been placed on divided highway design. Associated with any multiple-lane highway is the problem of eliminating cross traffic. Here arises the need for the side or adjoined service road and the corresponding need for a wide right of way.

The Highway Planning Survey already has analyzed very significant samples of the distribution of traffic with respect to length of trip beyond city limits. Data from 11 scattered states show that the percentage of out-of-town trips over 50 miles in length is small (0.8 to 2.4 per cent) and that more than 50 per cent of such trips are 10 miles or less in length. These data, in combination with the high concentration of metropolitan populations, indicate that in future considerably more emphasis must be placed on highway construction in the immediate vicinity of cities. Main connections through cities also justify a reasonable demand for funds.

In the more populous metropolitan areas, multiple-lane freeways, with elimination structures for cross transportation, will be very expensive. In October 1937, New York City opened the West Side Improvement, extending 138 blocks along the Hudson River—an example of a safe detour for through traffic around a city. The cost of this improvement is reported to be $24,340,000. This shows what we have recently learned to face in metropolitan areas. The cost of right of way in such cases will be large and often will exceed the cost of the highway itself. So far, indications are that the construction of adequate metropolitan by-pass routes is amply justified by the corresponding relief to other streets and the accelerated movement of through traffic.

A discussion of the last ten years of highway transport would be incomplete without including the subject of so-called secondary roads. Beginning with the passage

of the National Industrial Recovery Act on June 16, 1933, within the past five years federal funds have been available for the construction outright, or with federal aid, of secondary, or farm-to-market, or feeder roads. Provision has been made to construct 26,245 miles of such roads, and a large percentage of this mileage is now in operation. Federal funds amounting to $260,180,565 are involved. Current federal legislation regarding secondary roads provides $25,000,000 for each of the fiscal years 1938 and 1939. Authorizations for each of the fiscal years 1940 and 1941 are for $15,000,000. For these last four fiscal years, the federal money is to be matched on the usual basis by the several states. The application of matched federal funds was thus new for the 1938 apportionment. So far, about 26 per cent of the 1938 and 1939 apportionments combined have been used for completed work or work under construction or approved for construction. The total secondary-road mileage permissible for federal aid initially is limited to 10 per cent within each state.

UNDERPASSES ARE INCREASINGLY IMPORTANT
The One Shown Here Is in Albuquerque, N.Mex.

The term "secondary" frequently implies a low cost per mile, but it also applies to an auxiliary class of roads outside the federal-aid system, and in many states, outside the state system. Cost therefore is not an absolute criterion of a secondary road and varies greatly from state to state. The determination of proper secondary groups or secondary systems will be greatly assisted by the Highway Planning Survey. With a total highway mileage in the United States of approximately 3,000,000, we are faced with the problem of selecting from approximately 2,500,000 miles the worthy roads of secondary classification. From the federal standpoint, this initial selection is limited to about 300,000 miles. The value of the Highway Planning Survey data in making a proper choice is obvious.

ECONOMIC CONSIDERATIONS

In summing up and looking ahead, certain general conclusions seem clear. In the building of main rural highways we have been out of the mud for several years. There now is a trend toward a greater mileage of roads under state jurisdiction. Unfortunately, it is not yet paralleled by a larger state share of revenues. Meanwhile the states are confronted with exacting demands for increased speed and volume with safety on the main highways. There is also a marked shift away from local taxation for highways and toward support from operating revenue only. The total annual state revenue from licenses and gasoline taxes now runs to more than a billion dollars but is subject to constant diversion. There are also rebate abuses that cause economic loss. Both defects need correction.

Past tax rates on motor fuel and other rates have been governed largely by precedent from state to state. We now need a more precise and discriminating measurement of these operating revenues. We shall thus be led increasingly into a rate-making procedure. An equitable division of operating revenues as between, say, state highways, metropolitan highways, and secondary or local roads is also inevitable. Fortunately, the Highway Planning Survey will furnish much of the needed basic information. In particular it will show the mileage we can afford to own and operate. There finally will come a time when the maintenance and upkeep of established roads will require all the operating revenue.

Obviously we now need a fairly accurate forecast of motor traffic loads ten years hence. We also need to know the probable corresponding revenue for the budget. These forecasts are especially important as a guide to expensive multiple-lane construction, particularly in metropolitan areas.

The increasing number, size, and speed of motor trucks call certain facts to our attention. The rate of truck increase is very significant. On the main highways, trucks now constitute one out of every seven vehicles. Shortly they may be one in five. If we are going to have trucks that can climb hills better, we will not need so much reduction in grade. Here is an outstanding opportunity for cooperation between the highway engineer and the automotive designer. If for truck traffic we could use grades greater than 5 or 6 per cent for any considerable distance, much money would be saved in mountain grading. In this connection, the determination of the proper tax rate for trucks of varying capacity, and the corresponding control of overloads, becomes important.

There has been, and doubtless will continue to be, progress toward safer and more economic operation of all motor vehicles on the open road—better-riding and safer surfaces, better profiles for economy in rise and fall, better and safer cross-sections and alinement. With further reference to safety, we are about to have better accident reporting and statistics. We probably need better control of the positioning and numbers of patrolmen. It is doubtful whether the distribution of the highway patrol can be made properly by agencies independent of the state highway departments. Highway departments have the necessary traffic information and accident records. They also know the design of the individual highway and its relation to other designs and to the accident record. It is becoming quite clear that the presence of the patrolman plays an important part in safe traffic operation. In this connection, the records of policed tunnels and longer bridges are illuminating.

DETAILS OF CONSTRUCTION STILL NEED ATTENTION

Finally, some details of construction are not yet quite satisfactory. There is need for a better measure of the consistency of portland cement concrete; a closer determination of the proper consistency and temperatures of asphalt for black tops to ensure weather durability; a better understanding of the causes and cure of warping and cupping of concrete road slabs; and a better control of their transverse joints and especially of joint fillers. The great advances made in construction equipment should not be overlooked. The reduction in unit costs by improved grading equipment is remarkable. Also noticeable is the better finish of pavement surfaces secured with the newer finishing machines for concrete and bituminous jobs.

Settlement Studies on San Jacinto Monument

Field Observations Supply Data on Behavior of Isolated Footing on Deep Bed of Clay

FROM A PAPER PRESENTED BEFORE THE TEXAS SECTION

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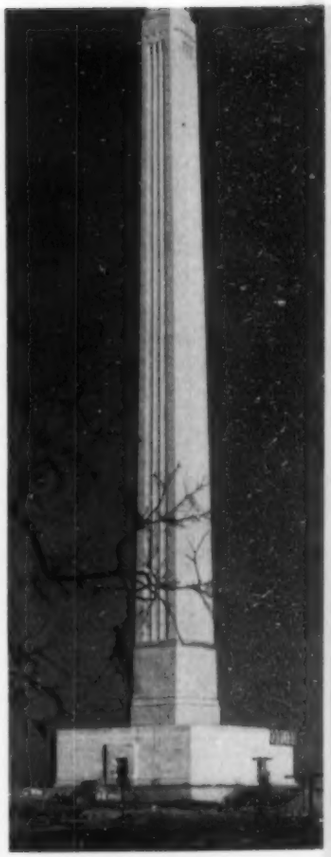


Courtesy of W. S. Bellows

A FIELD research project that should go far towards confirming or challenging the accuracy of settlement predictions has been in progress for almost two years at the San Jacinto Monument, in Texas. The monument rests on a 220-ft layer of clay, and the footing is a monolithic slab 124 ft on a side. At time intervals determined by the rate of settlement, the elevations of 44 points on this slab are carefully determined, and the settlements are compared with those previously predicted from laboratory tests and theoretical considerations. The accompanying article describes the technique of making the observations and presents the outstanding results to date.

AN ideal opportunity to observe the action of an isolated footing on a deep bed of clay is afforded by the San Jacinto Monument, near Houston, Tex. The studies, which are being carried on by the Bureau of Engineering Research of the University of Texas, include both laboratory tests and a continuing series of settlement observations on the structure itself, and have already provided valuable data on the coordination of laboratory and field results.

Design and construction of the San Jacinto Monument were covered in an article by Robert J. Cummins, M. Am. Soc. C.E., in the July 1937 issue of CIVIL ENGINEERING. As he explains, the foundation is a monolithic concrete base 124 ft square, reinforced with 2-in. square bars spaced $6\frac{1}{2}$ in. on centers in each direction. This footing rests on red clay 15 ft below the natural ground level, and the unit dead load on the underlying soil is 2.35 tons per sq ft. Borings show that the clay continues to a depth of 100 ft, and logs of wells drilled in the vicinity indicate that it extends to a depth of 220 ft and is underlain by a bed of sand. Physical characteristics of the clay are given in Table I.

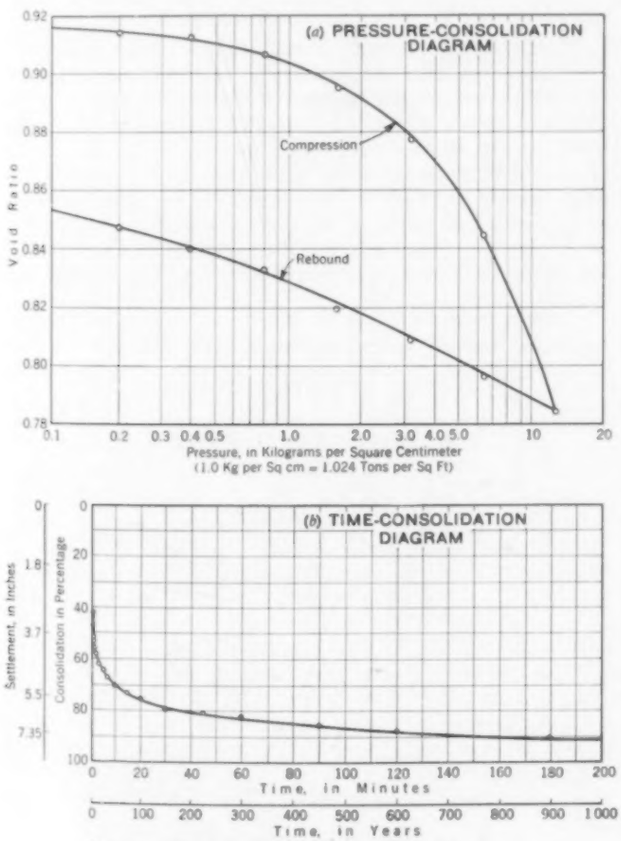


FIG. 1. DATA FROM LABORATORY TESTS

Prior to the construction of the monument, samples of undisturbed soil were obtained from the foundation area, coated with paraffin to prevent loss of moisture, and taken to the Bureau of Engineering Research for consolidation tests. (The general method of performing such tests was described by Spencer J. Buchanan, Assoc. M. Am. Soc. C.E., in the August 1937 issue.) Results from a typical specimen are presented in Fig. 1.

A load applied to the surface of the ground distributes itself throughout the soil in diminishing intensity in both the vertical and the horizontal direction away from the axis of the loading. Therefore, in order to estimate the probable settlement under a loaded area, it is necessary to determine the pressure distribution at a number of points under the area. Vertical pressures were computed at various depths for points under the foundation by a method given in Circular No. 24 of the University of Illinois Engineering Experiment Station. This is an integration for the Boussinesq equation, which assumes a homogeneous elastic solid of indefinite extent. As soils in general are not homogeneous, isotropic, or perfectly elastic, accurate results cannot be expected. Typical pressure profiles at five points under the footing are given in Fig. 2. These points were so chosen that the average of the pressures beneath them at any given elevation should be approximately the average of the pressure beneath the entire footing at that elevation.

TABLE I. ANALYSIS OF CLAY SOIL FROM MONUMENT SITE

Initial moisture content (by weight)	30.75 per cent
Initial degree of saturation	94.35 per cent
Initial void ratio	0.9138
Liquid limit	75.20
Plastic limit	28.43
Plasticity index	46.77
Centrifuge moisture equivalent (waterlogged)	85.18
Shrinkage limit	6.98
Volume shrinkage (based on wet volume)	58.0 per cent
Volume shrinkage (based on dry volume)	138.1 per cent
Linear shrinkage	25 per cent
Shrinkage ratio	2.057
Absolute specific gravity	2.795

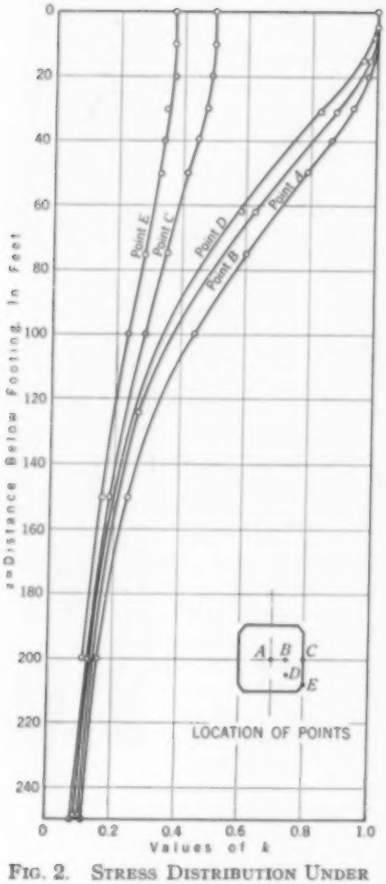


FIG. 2. STRESS DISTRIBUTION UNDER FOUNDATION

Values of k for Use in $p_z = kp$, Where p_z Is the Vertical Pressure at Depth z, and p Is the Unit Load on the Soil

The soil was then divided into imaginary layers 1 ft thick in the first 100 ft of depth, and 25 ft thick in the lower 100 ft. For each of these layers the average pressure due to the applied load was determined, as well as the average load due to the weight of the soil above the layer. The average weight of the soil above gives the initial pressure on the layer, and by adding to this the pressure caused by the applied load we obtain the average final pressure.

In excavating for the foundation, 15 ft of clay was removed. Theoretically, the addition of a weight equal to that of the soil removed will cause no settlement. Actually there will be a slight rebound when the soil is removed, and an equal amount of settlement when the equivalent load is applied. In this case the soil weighed 120 lb per cu ft, and a layer 15 ft deep weighed 0.9 ton, giving an effective load of 1.45 tons per sq ft on the soil instead of the calculated load of 2.35 tons per sq ft.

Taking the first layer of 10 ft under the footing, we find that the average initial pressure due to the weight of the soil is $\left(15 + \frac{10}{2}\right)\frac{120}{2{,}000}$ or 1.2 tons per sq ft. The average added pressure due to a load of 1.45 tons per sq ft, reduced according to the pressure distribution curves, is 1.13 tons per sq ft. This gives a final pressure of 2.33 tons per sq ft. From Fig. 1(*a*) we find that these pressures give an initial void-ratio of 0.901 and a final void-ratio of 0.887. Then we can calculate the settlement in this layer by $q = (e_i - e_f)h/(1 + e_i)$ where q is the settlement of the layer; e_i, the initial void ratio; e_f, the final void ratio; and h, the height of the layer. For the given conditions, $q = 0.88$ in.

In a similar manner the settlement of each of the other layers was calculated, and also the total settlement equal to the summation of the settlement of all the layers, expressed as follows: $Q = \Sigma q = 7.35$ in.

According to the theory of the consolidation process, the rates of compression of two layers of the same material under the same pressure conditions are directly proportional to the squares of the "reduced thicknesses" of the layers. The reduced thickness of a soil is the thickness of the solids with all voids removed. It is the true thickness divided by 1 plus the void ratio.

By determining the reduced thicknesses of the various layers and adding them, we can obtain the reduced thickness of the whole clay stratum. From this we calculate that one minute on the sample is equivalent to five years on the structure if the conditions are the same in both cases. On the sample in the consolidometer there were porous stones both top and bottom, permitting water drainage in both directions. If the clay under the structure can drain in only one direction it will take 4 times as long to consolidate, since the rates vary as the squares of the thicknesses. On the San Jacinto Monument there is an impermeable concrete mat above the clay, and therefore it might be considered that the water could only escape to the sand below. On the other hand, all the voids of the soil are not filled with water, so that a lateral movement of the water is also permitted. Under these conditions we may expect the settlement of the structure to follow the sample, especially at early ages when the water can move laterally.

It has been found that 90 per cent consolidation on the sample is equivalent to 100 per cent settlement in the field. This is true because the last 10 per cent of the consolidation takes place very slowly (theoretically at infinity) so that a practical limit is set for the time of ultimate consolidation.

From Fig. 1(*b*) we find that 90 per cent consolidation on the sample occurs in 160 minutes, which is 800 years on the structure. It may well be asked if 800 years is a practical limit, but by using this figure as a basis we can calculate the amount of settlement for shorter periods by placing scales on Fig. 1(*b*) for time in years and settlement in inches. We then find the following predicted settlement:

TIME IN YEARS	PER CENT SETTLEMENT	INCHES SETTLEMENT
800	100	7.35
100	75	5.51
5	50	3.68
1	35	2.57

The first requirement for settlement studies on a structure is permanent bench marks. The type selected for the monument observations is shown in Fig. 3. The essential parts consist of a 2-in. galvanized pipe 22 ft long used to case off the inner pipe from the soil. This depth is believed to be sufficient since the ground elevation is only about 18 ft above sea level. The outer pipe fits snugly in a hole bored in the ground and is approximately 4 ft shorter than the smaller pipe. The additional length of the inner pipe was driven into the ground. A

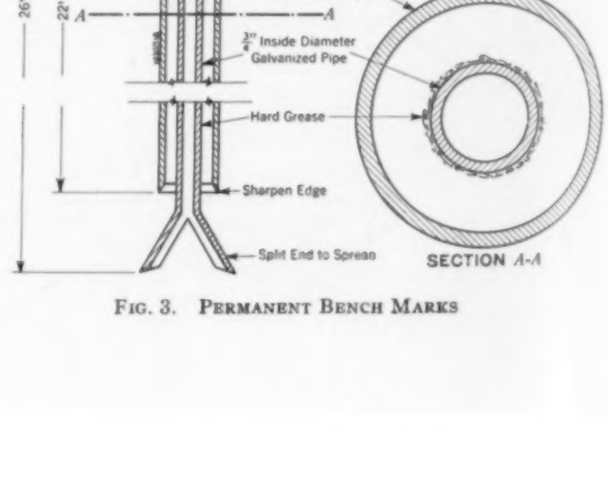


FIG. 3. PERMANENT BENCH MARKS

brass plug in the top of the inner pipe is used as the bench mark. The top of the pipe is inclosed in a concrete box covered with a cast-iron lid.

Three bench marks were placed in different locations at least 275 ft from the outer wall of the monument. Every time settlement readings are taken, the elevations of these bench marks are checked and rechecked, and to date there has been no movement.

At the time the footing was poured, small cans filled with paper were placed in the surface of the concrete. Later the paper was removed and the cans were filled with mortar. Round-headed bolts were set in the mortar to serve as observation points. There were also a number of pipes going through the concrete footing which were used to support the mixer boom during the pouring. Steel rods were set in mortar at the bottom of these pipes in order that we might have some observation points at the bottom of the slab. The plan of the base, Fig. 4, shows the location of the observation points. In all, 50 were set, but 6 were destroyed during construction.

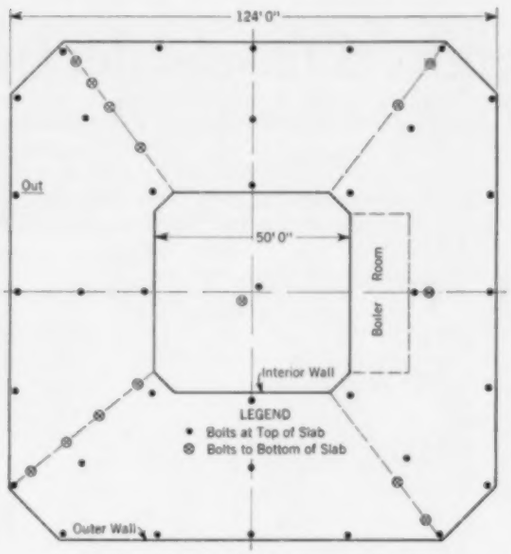


FIG. 4. LOCATION OF OBSERVATION POINTS

Construction forms and equipment prevented the taking of initial settlement readings until almost two weeks after the base was poured. Settlement during this period was approximately equal to the rebound caused by the removal of the soil.

The settlement observations are made by precise levels reading the target to 0.001 ft. A line from the three bench marks, using double turning points, is run into the basement and the elevations of the observation points are taken. The line is then carried back to the bench marks for a final check.

RESULTS OF OBSERVATIONS TO DATE

Figure 5(*a*) shows the maximum, minimum, and average settlements as well as the unit load on the soil. Usually the first question asked is how the actual settlement compares with that predicted. It will be recalled that from the laboratory tests we predicted a settlement of 2.57 in. in one year, and this curve gives an average actual settlement of 1.9 in. in the first year. But the load on the laboratory sample was applied instantaneously while that on the soil was being applied gradually over a period of approximately one year. If it is assumed that all the load on the structure was applied at the halfway point of the construction period, the first year of settlement would be completed about May 1, 1938. On this date the average settlement was 2.35 in.

By placing observation points in both the top and bottom of the footing, we expected to learn whether or not the shrinkage of the concrete would affect the results. To date no difference in settlement between the top and bottom of the slab has been noted.

A part of the difference between the maximum and minimum settlements shown in Fig. 5(*a*) is accounted for by the greater settlement near the center of the slab. This variation in settlement between different parts of the slab is more clearly indicated in Fig. 5(*b*), in which are plotted the results of averaging separately the settlements of the bolts near the interior wall, of those near the outer wall, and those midway between the walls. The last four readings show a definite tendency for the smallest amount of settlement to be at the outer edge and the greatest at the center. There may be a question whether or not such a heavily reinforced slab will deform sufficiently to permit greater settlement at the center. It is true that the top of the slab will shrink because of drying, while the bottom will be kept moist by the soil—and this of itself will cause the slab to curl upward somewhat at the edge. However, most of the "curling" is probably caused by an actually greater settlement at the center of the footing.

The Bureau of Engineering Research of the University of Texas expects to continue the settlement observations on the monument for many years and hopes to obtain sufficient data to be of real value. Much of the credit for this research goes to the architect, engineer, and contractor on the monument, all of whom actively cooperated with the bureau by supplying materials, help, and information whenever called upon.

Special mention should be made of Alfred C. Finn and Alfred C. Finn, Jr., architects; Robert J. Cummins, M. Am. Soc. C.E., engineer; and C. A. Bullen, Assoc. M. Am. Soc. C.E., superintendent for the W. S. Bellows Construction Company. In order to advance professional knowledge, they personally sacrificed time for the project when other duties were pressing, and without their help this study would not have been possible.

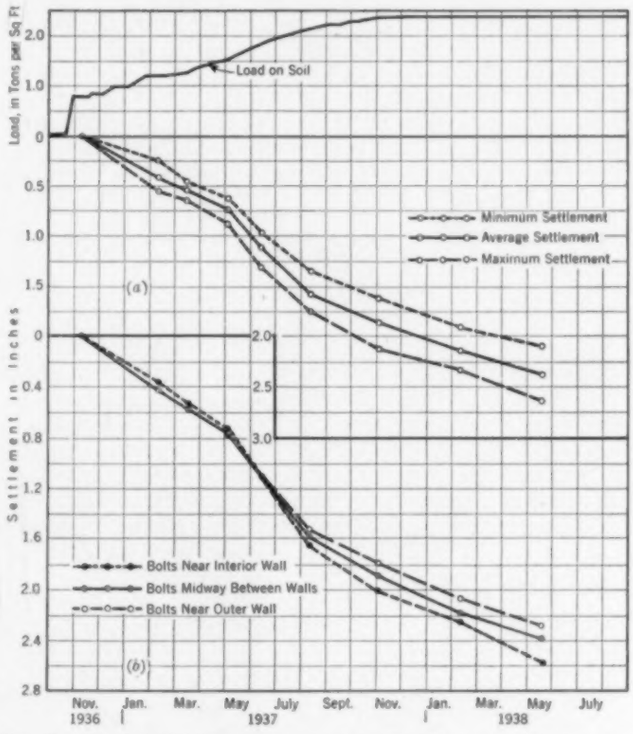


FIG. 5. SETTLEMENT OBSERVATIONS ON SAN JACINTO MONUMENT
(*a*) Minimum, Maximum, and Average (*b*) Average at Interior Wall, Outer Wall, and Points Midway Between Walls

Light-Weight Diesel-Electric Trains

Millions of Miles of Travel Have Demonstrated Their Economy and Reliability

By RALPH BUDD

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

PRESIDENT, CHICAGO, BURLINGTON AND QUINCY RAILROAD, CHICAGO, ILL.

"THE underlying virtue of reducing the weight of trains," said Mr. Budd at the 1938 Annual Convention, "is the avoidance of work—that is, the saving in expenditure of energy; while the underlying virtue of the Diesel-electric locomotive is efficient performance of such work as cannot be avoided. From an engineering standpoint the two constitute an ideal combination." His paper, here presented in abridged form, develops that thesis. It traces the development of the Burlington's Zephyr trains, and the evolution of the extremely light-weight passenger car into a unit practical for general use; and discusses briefly the economics of light-weight construction for both passenger and freight trains.

PRACTICALLY all railroad civil engineers whose activities date from the turn of the century will agree that the predominant subject of our attention until comparatively recent years has been that of advancing operating efficiency by reducing grades, curves, and distance, so that more tonnage could be handled in less time by a given locomotive. Of course, railroad mechanical engineers have been equally busy, and we have had many collateral activities such as enlarging roundhouses, and terminals, to keep pace with the heavier and longer locomotives and cars. The dominant theme has been a demand for greater efficiency.

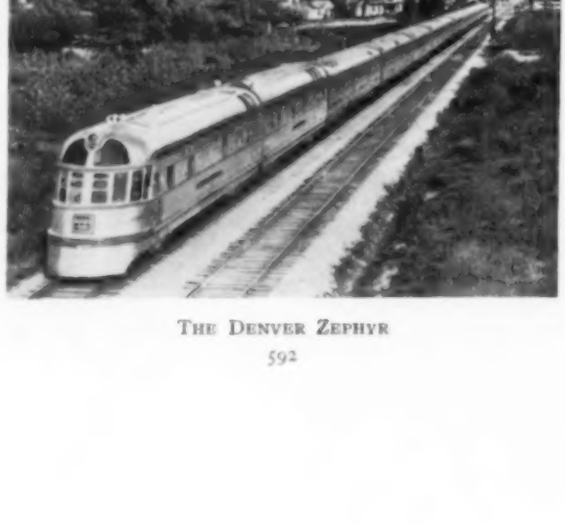
During the 1920's many improvements were effected in designing and allocating motive power to fit the established grades and other operating conditions, as the programs of grade and curve reduction were being completed. Thus heavy trains of uniform tonnage are handled for long distances over various operating divisions having quite different ruling grades.

Appropriations for the kind of improvements I have outlined, amounting to hundreds of millions of dollars, have been made upon recommendations of railway civil engineers. Formulas to determine the economic justification for the expenditures were developed in great detail and generally applied, although in the main, the projects that went well beyond the immediate requirements proved to be wiser than those that stayed within the limits of theoretical calculations based on existing conditions. If proof of the accuracy of this general statement were needed, it is found in the many instances where the same piece of line has been rebuilt more than once, and in the fact that bridges designed for Cooper's E-60 loading, for example, when E-40 would safely carry the current axle loads, have come much nearer to living out their normal expectancy than those which conformed strictly to contemporary requirements.

I emphasize this phase of railroad engineering because in it will be found the chief reason why the railways for many years were able to meet rising costs of wages, materials, and taxes, without corresponding increases in freight rates and passenger fares, and at the same time to finance the improvements. The total mileage of railways in the United States increased but 24 per cent between 1900 and 1937, while the property investment increased 148 per cent in the same period. In other words, since 1900 most of the money has been spent for improving and enlarging the plant rather than for increasing the mileage of road.

The subject assigned me on the Convention program, "Light-Weight Diesel-Electric Trains," may suggest an inherent association of Diesel engines and light-weight cars. However, we have always thought in terms of the basic advantage of eliminating weight from the cars, regardless of what motive power may handle them. The title further may imply a predominant interest in light-weight passenger trains, but the principle applies equally to freight cars. Indeed there are so many more freight cars than passenger cars, that weight reduction has much greater economic significance in that field than in the passenger car field. From the standpoint of operation, it is of course elemental to avoid all the work possible, and to do what remains with the utmost efficiency. Using a car that weighs less but carries as much or more load, saves work just as surely and simply as does shortening a line or lowering a mountain summit.

When built of "standard" materials, the increasing size of cars, locomotives, and trains that characterized the rising efficiency of railroad operation could mean only one thing—increasingly heavier rolling stock, track, and structures. The halting and eventual reversing of this tendency was made possible by the production of metal alloys which have either very low specific gravity or greatly increased strength. The latter class most nearly reaches perfection in stainless steel. Passenger cars built of aluminum and stainless steel weigh about the same, and that is about 60 per cent as much as the old standard cars. Various other alloys are suitable for certain parts of light-weight cars and especially for reciprocating parts of locomotives; and with still others it is possible to build freight cars which weigh 25 per cent less than so-called standard cars and to keep within reasonable cost limits.



THE DENVER ZEPHYR

Perhaps it will be worth while to state the considerations which led to the creation of the Burlington's first streamlined train of 1934. The idea back of this first "Zephyr" envisioned a comparatively small train, to take the place of a steam train on daily service between local places where travel was heavy but where most of it moved on the highway. A train that could be handled by a

single internal combustion engine mounted over the forward truck—the power truck—would insure the economy that had been proved with the gas-electric cars. Such cars had been in extensive use for more than ten years, but the concept of the new train embodied several vital departures. First, in addition to mail, express, and baggage, the new train must be able to accommodate a great many more people than had been riding on the old train, if it were to increase passenger revenue. Second, it must be operated at higher speed, for that was considered an essential passenger appeal. Third, it must be ultra-modern as to riding qualities, interior decoration, and air-conditioning. These combined demands necessitated the lightest possible weight consistent with absolute safety, and maximum elimination of wind resistance so that the minimum power plant could handle the maximum of train capacity, measured in seating and floor space.

MOTORMAN'S CAB, SHOWING "DEAD MAN'S" CONTROL

THE ORIGIN OF THE ZEPHYR

A stainless steel, gas-electric car built by the Edward G. Budd Manufacturing Company—in which some of us had the privilege of participating in a demonstration trip just out of Philadelphia on September 29, 1932—proved to be the specific factor that led to the first Burlington Zephyr. This car, which had been running more or less regularly since January 14, 1932, was mounted on pneumatic-tired wheels and had a gasoline engine. Neither of those features was acceptable, but it was the first railroad unit in this country, of which I have knowledge, that actually demonstrated, by operating under its own power, the possibilities of light-weight train construction. It was most impressive because it embodied a new process of fabrication—shot-welding—which preserves the great strength and rustlessness of stainless steel, that are so easily destroyed by ordinary electric welding.

Immediately following that visit to Philadelphia in September 1932, plans progressed for a small but complete and ultra-smart day train. Other strong alloys, as well as several features borrowed from the automotive industry, were embodied in those plans.

Some time later—perhaps in February or March of 1933—the fourth of the outstanding features of the Burlington Zephyr became something more than a hope. The Electro-Motive Company at that time advised us that we could count on their fullest cooperation in having for use in our new train, a two-cycle Diesel engine, rather than the four-cycle distillate-burning type, of which there were several already in service. No Diesel engine such as was then proposed had been built except for test purposes.

The two Diesel engines that furnished the power for the General Motors Building at the Century of Progress exhibition in 1933 were almost exactly like the one to be used in the original Zephyr, and their operation was closely followed by Burlington engineers. It seemed as if most of the questions of continuity of service and dependability of the engine had been resolved favorably when, late in 1933, difficulty was encountered in cooling the engine when mounted in a railway car. This caused delay, and there was some talk, in fact, of bringing the train out with a gasoline or distillate-burning engine, to be replaced later by the Diesel. Such progress was made with the cooling problem, however, that the train was delivered on April 18, 1934, powered by the first two-cycle Diesel engine ever placed in a streamlined train in America.

THE FAMOUS DENVER–CHICAGO TEST RUN

After several test runs of varying lengths it was decided to undertake a long trip at sustained high speed, and the route chosen was from Denver to Halsted Street, Chicago, which by the line through Plattsmouth is 1,015.3 miles. On May 26, 1934, this run was made successfully in 13 hours 5 minutes, at an average speed of 77.6 miles per hr, and a top speed clocked variously at 107 to 112 miles per hr, with not a single stop en route.

I mention this trip, not because it was spectacular, but because it was a most valuable demonstration in the interest of high-speed railway passenger traffic. It should be kept in mind that it was made without any preparation of the track, but on a very carefully worked out schedule, which was placed in the hands of officers most familiar with the roadway, one of whom rode continuously with the engineer and advised him of the permissible speeds at all points. Other track experts recorded the speed for each mile of the trip and made notes on how the train rode under the various conditions. The information thus gained as to the safety and comfort with which high speeds could be attained on track of known characteristics was invaluable and not obtainable in any other way. This information has been used by the Burlington since May 1934 in laying out its own track work; and it has also been made available, through technical papers and discussions, to railroads everywhere. There were also on the train during the run several of the Electro-Motive Company's technical men observing many features of the engine performance, and several officials and engineers of the Edward G. Budd Company checking the train's behavior. The latter were particularly interested in the effects of high speed upon passenger reactions. The design of the springs for a car that must travel 90 miles per hr naturally has to be different from that required for an operating speed of 60 miles per hr, and the solution of this problem in turn has a bearing on how much work has to be done to the track.

ARRANGEMENT OF ARTICULATED TRUCK

Many test runs have been made since May 1934, including one going westward over the same track, on October 23, 1936. This run covered the 1,015.3 miles from Halsted Street, Chicago, to Denver in 12 hours and 8 minutes, averaging 83.7 miles per hr, and attaining a maximum speed of 116 miles per hr. However, I know of no train performance which has had as much to do with the progress of the art of high-speed passenger train operation as that of the three-car Zephyr in May 1934.

The success of this small articulated train led to the construction of others, some of which are quite large. For longer and more complicated runs—that is, runs in-

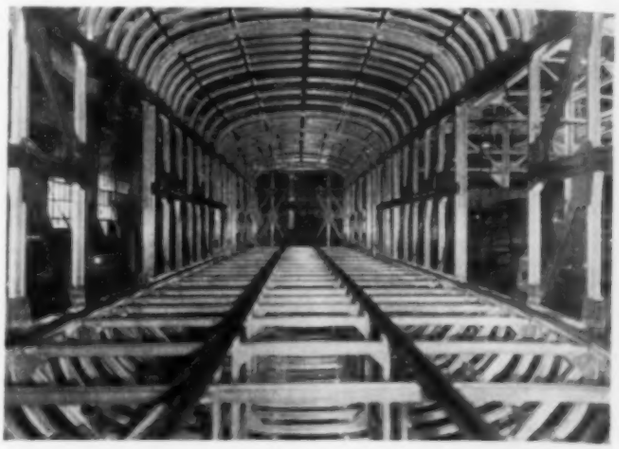
volving connections and junction points where cars need to be picked up or set out—and for trains on which the patronage varies greatly from day to day, interchangeability of equipment is important, if not essential. Also, on long-distance assignments coaches and sleeping cars are more luxurious and comfortable if built the maximum permissible width, which is about 10 ft outside. The newer cars embody both interchangeability and extreme width. There has thus been sacrificed, in later light-weight trains, considerable of the operating economy of the original Zephyr in order to have cars that can mingle with so-called standard or conventional equipment. No way has been found to avoid these less economical features such as greater width and height, the latter being necessary to conform to standard floor and coupler height. The area of cross-section of the front of the original Zephyr is 100 sq ft; that of the Denver Zephyr is 130 sq ft. The top of the original Zephyr power car is 12 ft 2 in. above the rail, compared with 13 ft 10 in. for the Denver Zephyr locomotive. The tops of the trailing cars in each case are about a foot lower.

We have thus arrived at the point where the light-weight passenger car has evolved from the extreme of economy and efficiency into a unit that is practical for general use. Through the gradual retirement of conventional cars and the introduction of modern cars, passenger trains finally may become more or less uniformly streamlined. A current question is: How much is it economical to spend to eliminate weight in a passenger car that can be handled in a train along with conventional cars? Except in those smaller trains where a Diesel engine can be placed in the forward car, a choice of motive power is necessary also, and here the question is how much additional money, if any, should be spent for a Diesel rather than a steam locomotive, to handle the high-speed train. I think there are no formulas by which these questions can be resolved. Some things we do know—among them that the light-weight stainless steel cars, whether on small- or large-size trains, withstand rough usage, including collision and derailment, better than so-called "standard" cars. We know that the maintenance cost of cars with stainless steel structural members is low compared with our other cars, and that the stainless steel sheathing can be kept clean much more easily and cheaply than cars which have painted exteriors.

DIESEL-ELECTRIC TRAINS ARE EASY ON TRACK

We also know that our Diesel-electric light-weight trains are easy on track. In order to have any train ride with perfect comfort at high speed it is of course necessary to have track that is in good line and surface, but these trains do not affect line and surface of track or damage the rail, as has been found to be the case in some instances with other types of trains and locomotives, even with locomotives of recent construction. We believe this is largely because the heaviest axle loads are only 54,000 lb, the traction is applied through rotary motion, and the center of gravity is low. It has been said that low center of gravity causes excessive side thrust, tending to spread the rails and force track out of line, but careful inspections and special checks have convinced our track officials that Zephyr trains do not produce such effects. While it may be impossible to reduce to exact dollars and cents the value of the benefits just related, we do know that the financial results from the operation of our light-weight trains have been highly satisfactory both through increased revenue and economy of operation.

In the future most of the installations of new light-weight cars probably will be in existing trains along with old equipment. What can be accomplished along this line is sometimes quite remarkable. Lightening the



SHOT-WELDED STAINLESS-STEEL CONSTRUCTION

tonnage may avoid double-heading; it may avoid running the train in two sections; or it may enable the handling of the train in one section with a smaller locomotive than would otherwise be necessary. In the summer of 1937, for example, Burlington passenger traffic between Chicago and Denver was so heavy that the alternatives just mentioned had to be resorted to. To handle 17 cars, the average summer train, it was necessary to use a modern 4-8-4 locomotive instead of the 4-6-4 type, which is adequate during the rest of the year. Now, had there been 8 really light-weight cars and 9 heavy cars in each train, instead of 17 heavy cars, the 4-8-4 locomotives would not have been needed—and all of them could have been used profitably at that time for handling freight trains.

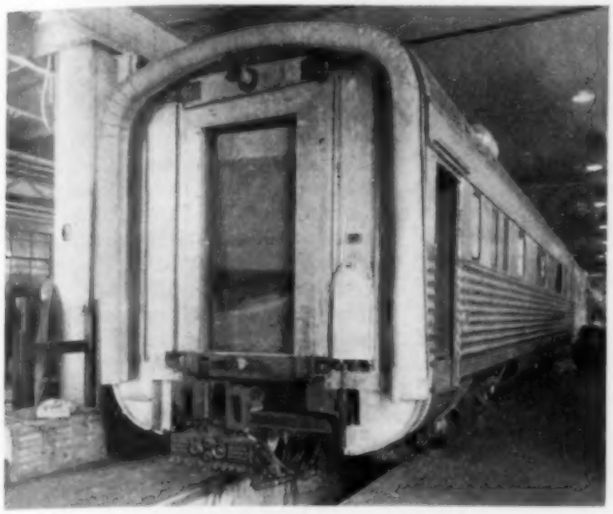
The value of reduced stresses in track is as difficult to fix as anything connected with train operation. Although it is a hidden value it is no less important. Speed is a direct factor in track stresses, and it is highly desirable to avoid excessive speed with equipment not especially adapted to it. The lowest possible maximum speed is attained by elimination of all service stops en route, so that the train can be kept running more nearly continuously. A Diesel-electric, on the run between Chicago and Denver, requires about 45 minutes less servicing time en route than a steam locomotive. If the eastbound Denver Zephyr, which uses 15 hours 38 minutes to Chicago, is delayed 45 minutes in leaving Denver, its average speed for the 1,039-mile trip in order to arrive at Chicago on time will be increased from 66.5 to 69.8 miles per hr. The top speed would have to be about 100 miles per hr instead of about 90. The purpose is to make a very fast over-all schedule with the slowest possible maximum.

Based upon four years' experience and 5 million high-speed train-miles, Burlington practice as to allowable speeds for various degrees of curvature, superelevations, and spiraling is shown in Table I.

This table allows for $1^1/_4$-in. rise in outer rail per second of time. Superelevation is held to 5 in. because of the freight trains which are operated over the same track.

The availability for service of the Diesel-powered trains, in spite of their extremely fast schedules, has been about 95 per cent. Chicago-Denver service was inaugurated on May 31, 1936, and up to July 15, 1938, the Diesel locomotives assigned to these trains had averaged more

than 1,030 miles a day. This schedule has been maintained by two locomotives, without a standby or spare unit. Current maintenance is handled during the eight-hour daily layover and consists of replacement of moving



AUTOMATIC TIGHT-LOCK COUPLER AND TRAIN LINE CONNECTORS

parts, such as wheels, pistons, cylinder liners, rods, gears, and bearings. These are made on a mileage schedule, or on a basis of tolerance in the case of wheels, gears, etc., the renewals of course being made before failure of the parts. A major job, such as changing crank shafts, will require perhaps a week in the shop, but experience to date indicates that a crank shaft need not be changed oftener than about once every million miles. In the most severe service, this would be about every two and one-half years.

The cost per train mile for locomotive maintenance, locomotive fuel, and lubricating oil on the four smaller Zephyrs (3 and 4 cars each) has averaged 6.87 cents. The cost per locomotive mile for steam-drawn trains of the same carrying capacity has been 28.98 cents. Of course, these were not new steam locomotives, and their schedules were less exacting. For the larger trains, comparisons are more difficult, because we have no similar steam schedules. The cost of locomotive maintenance, locomotive fuel, and lubricating oil for the Diesel locomotive now handling seven trailing cars has been 15.0 cents per mile, and for the Diesel locomotive handling ten trailing cars it has amounted to 21.6 cents per mile.

ECONOMIC ADVANTAGES OF LIGHT-WEIGHT FREIGHT CARS

Full light-weight construction is of more importance in passenger than in freight trains in so far as track maintenance is concerned. In the freight car the advantage of light-weight construction is of another kind—namely, that of improving the ratio between the weight of the car and the load it will carry. A train of 60 loaded cars might weigh 4,000 tons, about 1,500 tons of which might represent the weight of the cars and 2,500 tons, their contents. Reducing the weight of the cars 25 per cent, or 375 tons, and increasing the loading by 375 tons would leave the gross train tonnage at 4,000, but at 1 cent a ton-mile revenue it would increase the earnings per train-mile by \$3.75, or 6¼ cents per car-mile. If such a car should make 5,000 loaded miles a year, there would be a gain of more than \$300 a year by reason of its weighing less but carrying more. Moreover, 12 per cent fewer cars will be needed to move the same amount of traffic. This is getting away from my subject but it is a good field for exploration. In view of the large number of freight cars that are retired and replaced annually, it is an important question to determine how far a railway can economically go in increasing the cost of new cars in order to reduce their weight and increase their carrying capacity.

One word more about the similarity of results from handling lighter equipment compared with handling trains over lighter grades and shorter distances. It is

TABLE I. ALLOWABLE SPEEDS ON CURVES
(Burlington Practice)

DEGREE OF CURVE	SUPER-ELEVATION, IN INCHES	LENGTH OF SPIRAL, IN FEET	MILES PER HOUR	
			Zephyr	Conventional
Under 1	...	...	No restriction	
1	3½	410	100	90
1½	5	500	90	80
2	5	465	80	70
3	5	385	65	60
4	5	325	55	50
5	5	290	50	45
6	5	265	45	40

perhaps a fortunate circumstance that the grade and line changes were mostly made during a period when increasingly heavy equipment was the standard. Otherwise, the economic justification for those improvements would not have been so obvious. As it is, nothing has been lost. Lighter cars, making higher speeds easier of attainment, and in the case of freight trains making for larger pay load, get full benefit from the improvements in fixed property. They also save in cost of transportation wherever they are handled—even if it is on level track.

Light-weight and semi-light-weight streamlined passenger cars have become commonplace. Selection of the type and construction is a matter of economic calculation and justification for making the purchases of the new cars decided upon. These cars may be in entirely new trains, which vary all the way from the extreme of lightness, as in the articulated train unit on the one hand, to a large semi-light-weight non-articulated train unit on the other; or a single car may be placed in an otherwise conventional train.

DIESEL-ELECTRIC LOCOMOTIVES A SUBSTITUTE FOR ELECTRIFICATION

Diesel-electric locomotives handle practically all the articulated train units. They also handle some of the trains made up of combinations of streamlined and conventional cars; and in some important instances, such as the Baltimore and Ohio's Capitol Limited, they handle full trains of conventional cars. Where electrification is not justifiable for lack of traffic density, Diesel-electrics may be regarded as a substitute, and are especially adaptable to schedules that are very fast. Their advantage of course is that, like electric locomotives, they avoid service stops en route, and are available for service almost continuously. On the other hand, their high first cost makes it necessary that their assignments be such as will give large daily and yearly mileage, so that the least possible number of them will be required for a given train schedule. We have here again a problem of engineering economics—how much is it worth to have the advantages of Diesel-electric performance in certain situations? There is no general formula, but many data based upon experience are becoming available for use in reaching a decision.

Model Testing of Seaplane Hulls

Intricate "Take-Off" Problems Are Solved in World's Largest Towing Tank, Maintained by National Advisory Committee for Aeronautics

FROM A PAPER PRESENTED BEFORE THE VIRGINIA SECTION

By JOHN R. DAWSON, JUN. AM. SOC. C.E.

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THE value of a seaplane depends on its load-carrying capacity, and this in turn quite obviously depends on its ability to take off. To solve the "take-off" problem, the designer must know, among other things, the water resistance of the hull and floats. As in the case of ships, this factor can best be determined from experiment with towed models. However, the ordinary ship-model tank does not provide the proper facilities. Mr. Dawson here describes briefly the special tank at Langley Field, Va., where these tests are constantly being carried on, and then explains in some detail the nature of the tests and the principles involved in interpreting them.

THE Langley Memorial Aeronautical Laboratory, maintained by the National Advisory Committee for Aeronautics (N.A.C.A.) at Langley Field, Va., is probably the most complete laboratory devoted to aeronautical research in the world. One of its interesting features is the towing tank used for studying the behavior of seaplane floats and hulls on water.

For many years model studies have been used in the design of ship hulls. In this country there are ship-model tanks in Washington, D.C., Hoboken, N.J., Newport News, Va., and Ann Arbor, Mich.; and many other countries have similar installations. These ship-model tanks are not well adapted to research on seaplane floats and hulls, however, for the speeds of their towing carriages are usually too slow. A tank with a maximum speed of carriage suitable for a 20-ft model of a ship might be able to tow a model of a seaplane float no more than 1 ft in length. Because of the small forces excited by small models and the errors introduced in converting the results of the tests to the full-size float, the need for a high-speed towing tank for aeronautical research is apparent.

In 1929 Congress provided the N.A.C.A. with funds for the construction of such a tank. Starr Truscott, M. Am. Soc. C.E., was placed in charge of the design and construction of the tank and has remained in charge of its research operations since its completion.

As originally conceived, the tank was to be 10 ft wide, 5 ft deep, and about 1,000 ft long. The money provided was considered to be sufficient to build such a tank. A further study of the problem, however, indicated that a larger and longer tank would be very desirable. It was accordingly decided to attempt to build a tank 24 ft wide, 12 ft deep, and about 2,020 ft long, equipped with a towing carriage capable of maintaining a constant speed of 60 miles per hour for sufficient distance to permit the required readings to be taken.

The problem before the designer was to build the longest towing tank in the world and construct equipment that would enable the testing of models at speeds nearly twice as fast as had ever been used before. With the funds limited to the original appropriation, only those features which were absolutely essential could be incorporated. The requirements were successfully met, and the tank was put in operation in 1931.

The tank is shown in section in Fig. 1. Space does not permit an account of all the problems in its design and construction, but two of them may be mentioned briefly.

One of the most troublesome problems in the design of towing tanks is the design of the track and the running gear for the carriage. In order to ensure steady conditions while running, the wheels must be truly round and the rails truly level and straight. All previous tanks had had carriage wheels with hardened and ground steel tires, and rails machined straight throughout their lengths. The cost of such an installation in the present case would have been prohibitive. It seemed that a more practical method would be to use pneumatic rubber tires on the wheels and simple H-beams for the rails. This opinion has been completely vindicated by the success of the installation, and similar carriages have since been built in at least one other country.

The leveling of the rails still presented quite a problem because of the accuracy which was desired. To accomplish it, the tank was filled with water and used as a continuous level, and a gage for measuring the distance from the water surface to the rail was developed. This gage consisted of a rod having a platinum point mounted on a micrometer head and wired so that it completed a circuit through a neon light when it touched the water surface. The accuracy of this gage was found to be ±0.0001 in.

When the work of leveling began, it was found that there was a surge running up and down the tank—even when it was left completely closed and undisturbed for days. This wave sometimes reached a height of $^1/_4$ in.—and as the height of rail was to be measured to 0.01 in., no satisfactory work could be done under these conditions. By repeated observation it was determined that there were times when the surge died down to 0.01 in. or less,

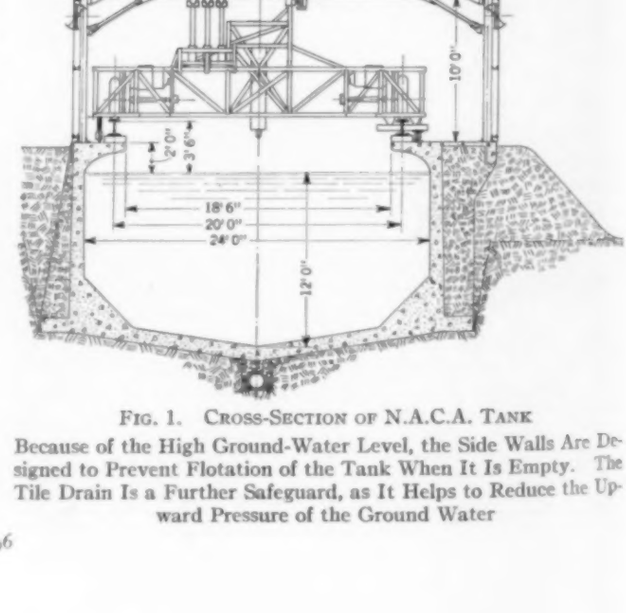

FIG. 1. CROSS-SECTION OF N.A.C.A. TANK

Because of the High Ground-Water Level, the Side Walls Are Designed to Prevent Flotation of the Tank When It Is Empty. The Tile Drain Is a Further Safeguard, as It Helps to Reduce the Upward Pressure of the Ground Water

so that it was merely necessary to work when such conditions obtained. Unfortunately, these conditions could not be depended on to obtain at any specified time—though usually they occurred after midnight. Eventually the job was completed by persistently following the movements of the surge.

The continued rapid development of seaplanes indicated that speeds in excess of the 60 miles per hour of the N.A.C.A. towing carriage would be desirable for testing purposes. To accomplish this, as well as for other useful purposes, the N.A.C.A. tank was extended 900 ft last year (1937), and the carriage has been altered to increase its speed. The extension brings the total length of the tank to 2,920 ft, and the designed maximum speed of the present carriage is 80 miles per hour.

The primary object in the usual tank test is to determine the water resistance that will be encountered in the take-off run by the actual seaplane. For a given hull or float, the usual independent variables that may affect the resistance during take-off are load, speed, and trim. (Trim, or "attitude," is the angle between the horizontal and some reference line on the hull.) The usual resistance curve is a plot of resistance against speed, from rest to getaway speed. Obviously, with three independent variables, more than one resistance curve may be obtained. It has been found, however, that there is in general for any given speed and load a trim that will give minimum resistance. Now minimum resistance is just what is desired, so the curve of minimum resistance is obtained together with a corresponding curve of trims. The problem is then to cause the seaplane to maintain the best trim throughout take-off. To do this it is necessary that the pilot have sufficient control, and that he know the trim of the seaplane at all times during the take-off.

To find out whether the pilot will have sufficient control to maintain best trim it is necessary to determine all moments acting on the seaplane. The moments due to water forces are, of course, obtained in the tank tests; the others are determined by aerodynamic tests or by approximate calculations.

In order to provide means by which the pilot may know the trim of his craft at all times, the N.A.C.A. has developed a trim indicator which uses the horizon as a point of reference. In preliminary tests this instrument has proved very satisfactory.

Near the getaway speed the control moments available are large because of the high speed at which the seaplane is traveling. During this stage of the take-off, the moments due to the water forces are usually small so that there is little question regarding the ability to maintain the best trim. But at slow speeds the situation is reversed, the water moments becoming quite appreciable. Unless special aerodynamic tests have been made specifically to determine the control moments available at low speeds, only a poor approximation can be made in computing them because of the great variation in such moments for different designs—the position and characteristics of the propellers greatly affect them. The customary assumption that the resultant aerodynamic moment is zero at low speeds is probably conservative enough to provide a safety factor that will be very welcome when the seaplane is completed and found to be heavier than expected. The condition in which only the water moments act on the seaplane is called "free to trim"—from the assumption that the pilot does not have to move the controls to obtain the condition.

The model, which is usually made of wood, is attached to the carriage towing gear in a manner that permits the towing pull to be applied at a transverse axis corresponding to the position of the center of gravity of the full-size

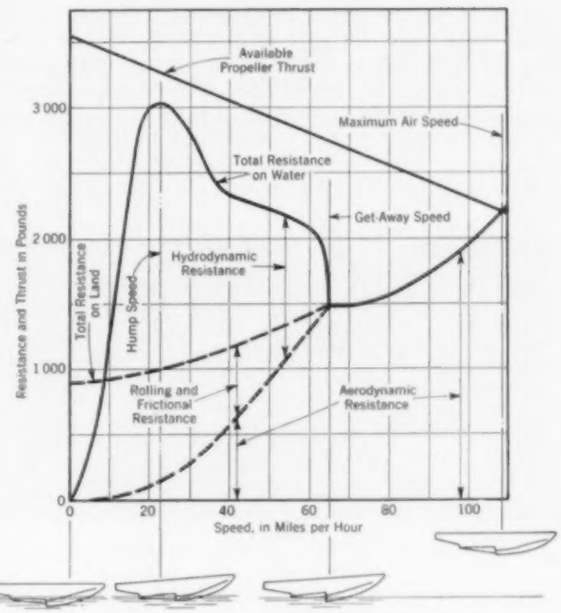

FIG. 2. TYPICAL CHART SHOWING FORCES ON AMPHIBIAN DURING TAKE-OFF ON LAND OR WATER

seaplane. The gear is so arranged that the moments of the water forces may be measured; or the model may be left free to trim—that is, balanced to bring the center of gravity to the designed position, and allowed to pivot freely about the transverse axis through that point.

THE TECHNIQUE OF TESTING

It would seem that the quickest and easiest way to duplicate the resistance obtained during take-off would be to accelerate the carriage from rest to the speed corresponding to getaway speed, taking continuous records of the variation of all the characteristics that are desired. If this method is used, however, special care must be taken to avoid the effects of the acceleration of the various parts of the dynamometer, and even of the model, on the readings. This would require the use of costly equipment and models. The working up of the results also has been found to require more time than when tests are made at a series of constant speeds. Consequently, the usual practice is to determine the resistance and other quantities at a sufficient number of constant speeds to cover adequately the range of speeds to getaway, and to draw curves through these test points to indicate the variations with speed. This procedure theoretically introduces an error due to the energy required to start or change a wave system, but this error does not appear to be as large as others that are seemingly unavoidable.

While the seaplane is at rest on the water, its whole weight is supported by the buoyant forces exerted on the hull. During the take-off run the support is gradually transferred from the hull to the wings as the lift of the wings increases. The lift of the wings, however, varies with both the speed and attitude (angle of attack); and unless these data are available in detail, the load that should be supported on the model at a given speed and trim cannot be precisely determined at the time the tests are made in the tank. The manner in which the load is applied is the principal distinction between the two types of tests conducted at the N.A.C.A. tank.

In the "specific" type of test, the load corresponding to the gross load of the seaplane is applied to the model

with the carriage at rest. A hydrofoil is then attached to the carriage near the edge of the tank, and set in the water so that when the carriage moves, the hydrodynamic force on the foil will act downward. This force is transmitted to the model by means of a cable passed over sheaves so that the force tends to raise the model and thus reduce the load on it. The attitude of the hydrofoil is then adjusted so that it will pull the model clear of

GETTING SET FOR A 60-MILE-AN-HOUR RUN

the water at the required getaway speed. At speeds between zero and getaway the lift produced by the hydrofoil varies approximately as the square of the speed, thus approximating the load curve that would be given if the seaplane were held throughout the take-off run at the attitude at which it takes off. The approximation thus obtained is usually satisfactory.

The specific test, as its name implies, is usually used for a specific design. It is necessary to know or assume certain features about a design before the set-up conditions can be determined.

The other type of test in use at the N.A.C.A. tank is known as the "general" tank test. In this test the load is varied in increments by means of dead weights. It is customary to determine the range of load parameters that are likely to be useful for the model being tested, and to obtain a sufficient number of test points to draw curves of resistance and trimming moment plotted against speed, with load and trim as parameters.

It is not necessary to know to what design the type of hull being tested is to be applied, as the results may generally be used to indicate the performance that would be obtained if the hull represented by the model were used with any design that does not demand conditions outside the range of those tested. It is not even necessary to know the center of gravity of the seaplane, for only a simple calculation is required to transfer all moments to any desired center of gravity.

It is, of course, only a matter of testing a sufficient number of trims to determine the best trim with either the specific or general type of test.

A typical set of curves from which performance calculations are made is shown in Fig. 2. In this figure the thrust, air drag, and total resistance (that is, water resistance plus air drag), are plotted against speed. At any speed, the accelerating force is represented by the distance between the thrust curve and the total-resistance curve. From these data it is easy to compute the time and distance required for the given craft to take off.

The resistance curve shown here is typical. There is an increase in resistance until it reaches a maximum called the "hump." Beyond the hump, the resistance drops off rapidly at first, and then levels out to a more gradual gradient until almost at getaway speed. At speeds lower than the hump speed, the buoyancy forces predominate in supporting the hull; and at speeds higher than the hump, the dynamic forces predominate.

The fundamental dimensional equation for the resistance of a fluid to a body moving through it may be used to show the difficulties encountered in converting the results of tank tests to full-size seaplanes. This equation is $R = \rho L^2 V^2 F\,(\rho L^2 V^2 C, Lg/V^2, LV/\nu)$, where R is the fluid resistance; L, the linear dimension of the body; V, its speed; F, an undefined function; g, gravity acceleration; and ρ, C, and ν are respectively the density, compressibility, and kinematic viscosity of the fluid. For similitude each of the terms within the parentheses must be the same for both model and prototype.

Fortunately in tank tests the fluid is compressed so little that the term, $\rho L^2 V^2 C$, which represents the forces due to the compressibility of the fluid, may be neglected. The term Lg/V^2 (the reciprocal of Froude's number squared) represents the forces due to gravity. These forces are largely expended in wave-making. The term LV/ν (Reynolds number) represents the forces due to the viscosity of the fluid—that is, the frictional forces.

Obviously, the requirements of the Reynolds number and the Froude number are incompatible as long as the model is to be towed in water. The Froude number requires that the model speed equal the seaplane speed divided by the square root of the linear-scale ratio (seaplane length ÷ model length); whereas the Reynolds number requires that the model speed equal the full-size speed multiplied by the linear-scale ratio.

The method used in determining the resistance of ship hulls is to compute the frictional resistance of both the model and the full-size ship on the basis of data obtained from the towing of flat plates, the wetted area being necessary for such computations. The frictional resistance of the model is then subtracted from the resistance obtained in the tank tests and the remaining resistance converted to full size on the basis of Froude's law. It is then only necessary to add to this converted value the frictional resistance computed for the ship, in order to obtain the total water resistance of the ship. This method is impractical in the case of seaplanes, however, because not only does the wetted area vary greatly but the speed with which the water flows over certain portions of the hull may differ greatly from the speed of the seaplane. Furthermore, the after-portion of the hull may contribute resistance due to spray striking it, and the data on frictional resistance of water could hardly be expected to apply to a broken-up spray.

In the case of seaplanes it is customary to convert all water resistance from model to full scale on the basis of Froude's law and to ignore the fact that frictional resistance does not obey this law. The errors caused by this method are usually on the conservative side, but they make it desirable to tow models as large as convenient.

FACTS ABOUT THE N.A.C.A.

The N.A.C.A. is an independent government establishment reporting directly to the President. It is composed of 15 members appointed by the President and confirmed by the Senate. The members serve without compensation. The chairman of the committee is Dr. Joseph S. Ames, president emeritus of Johns Hopkins University, and the vice-chairman is Dr. D. W. Taylor, former chief of the Bureau of Construction and Repair of the Navy. Members include the chief and assistant chief of the Army Air Corps, the chief and assistant chief of the Bureau of Aeronautics of the Navy, the director of the Bureau of Air Commerce, the director of the National Bureau of Standards, the secretary of the Smithsonian Institute, and the chief of the Weather Bureau. Nongovernmental members include such men as Colonel Lindbergh and Dr. Orville Wright.

West Virginia's Rural Sanitation Program

Sanitary Earth-Pit Privies Built Since 1933 Improve Health Conditions for 700,000 Persons

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THE work of the engineer in municipal water supply and sewerage during the past half century is well known. It has made possible the present low mortality from typhoid fever and associated intestinal diseases in urban areas. Yet no comparative reduction of these diseases was effected in rural areas because no practical procedure was advanced for reaching the individual water-supply and excreta-disposal facilities of the rural home. Education of the rural population in environmental sanitation through full-time county health units has been advocated as the best approach to the problem but has not been conducive to quick results. The very communities most in need of a health service are those least able to pay for it.

Rural dwellers have been unbelievably backward in providing for the proper disposal of body wastes. During 1933 a survey of over 68,000 homes in West Virginia depending upon the privy, revealed the following:

Homes using grossly insanitary surface privies . . .	80 per cent
Homes using privies with pits, but pits not fly-tight	13 per cent
Homes with no method of excreta disposal, privy or otherwise	5 per cent
Homes with approved privy with fly-tight pit . . .	2 per cent

While these figures were obtained in West Virginia, they indicate a condition common to many states, northern as well as southern. The problem was particularly acute in West Virginia because the chief industry, the mining of bituminous coal, had been in a bankrupt state for almost a decade. Sanitation was generally poor at operating camps; at bankrupt mines the squalor and misery presented a depressing picture of our economic and industrial system. The effect of poor sanitation in the depressed mining areas is reflected in the high typhoid-fever death rate in West Virginia prior to 1933, as shown in Table I. From 1923 to 1935 the average death rate for the disease per 100,000 population in the five leading coal producing counties was 15.1, while the average for the whole state was 10.9.

TYPICAL VIEW IN A MINING CAMP NOT YET REACHED BY THE RURAL SANITATION PROJECT
Open-Back Privies Deposit Excreta Along the Stream

The allocation of funds by the federal government for work relief has made proper sanitation in rural West Virginia a reality. With the irrefutable argument that insanitary disposal of human excrement at a home affects the surrounding community as well as the individual family, authority to develop a work relief project for the construction of sanitary earth-pit privies at private homes, rural schools, and public places was granted in 1933. A large sum of relief money was being spent on municipal sewerage improvements, why not benefit the rural communities where sanitation was needed even more?

HOW THE COMPLETED UNIT LOOKS
The Sign Calls Attention to the Fact That This Was the 100,000th Unit Constructed

Although some unorganized work along the same line had been done earlier in the year, it was in December 1933, that a state-wide community sanitation program began in West Virginia under the Civil Works Administration. The project was sponsored, and technical supervision furnished, by the U. S. Public Health Service in cooperation with the State Health Department. With only short interruptions the project has been continued under the FERA and WPA.

TABLE I. DEATHS PER 100,000 POPULATION FROM TYPHOID FEVER, AND FROM DIARRHEA AND ENTERITIS (UNDER 2 YEARS OF AGE), FOR 1923–1936 IN WEST VIRGINIA AND THE U. S. REGISTRATION AREA

YEAR	TYPHOID FEVER		DIARRHEA AND ENTERITIS (Under 2 years)	
	W.Va.	U.S.	W.Va.	U.S.
1923	16.3	6.8	76.1	32.1
1924	14.5	6.7	56.0	27.5
1925	21.0	8.0	88.3	31.5
1926	16.9	6.5	76.6	27.0
1927	13.4	5.5	62.0	21.6
1928	10.5	4.9	50.1	20.7
1929	11.5	4.2	57.7	17.9
1930	12.1	4.8	70.2	19.6
1931	12.7	4.5	54.6	15.7
1932	12.2	3.7	50.5	12.0
1933	7.7	3.5	32.2	12.5
1934	6.8	3.4	26.6	13.5
1935	5.2	2.8	23.0	10.4
1936	4.1	2.5	33.1	12.2

As the administration of the Community Sanitation Program has not materially changed since its inception, the present organization will be described. The technical supervision is in the hands of an assistant state

director, who is responsible to the state health commissioner. The state is divided into six administrative districts to correspond with the six WPA districts. Each district is under a district sanitary supervisor. The program in each of the 55 counties is directed by a county sanitary supervisor, under whom there may be from ten to a hundred workers from the relief rolls. During 1936 an average of 2,000 persons were employed on the project. A county may have one or more canvassers, whose chief duty is to solicit orders for sanitary privies from property owners. Salaries and expenses of the assistant state director, the district supervisors, and certain clerical help are paid by the sponsors. All other workers are paid from WPA funds.

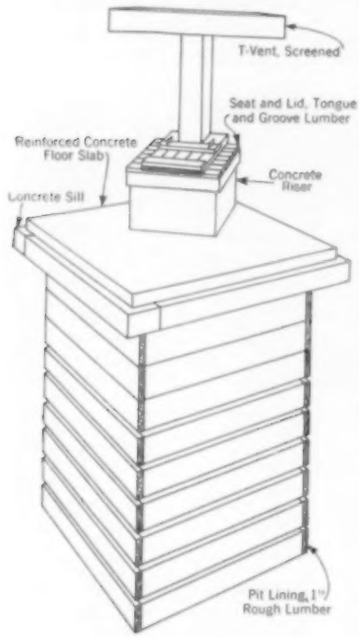


FIG. 1. SKETCH OF THE STANDARD SANITATION UNIT

The routine of providing a sanitary privy will be described. A canvasser calls upon the property owner and, if an inspection reveals insanitary disposal of excreta, explains the program. The property owner agrees to provide all material at the site necessary for the construction of a unit built in accordance with a standard State Health Department plan. As soon as convenient, a crew of workers come and erect the unit at no labor cost to the property owner. The property owner then signs a receipt for the completed unit. Construction receipts are filed at the State Health Department but later will be turned over to the county health departments.

TYPE AND COST OF CONSTRUCTION

The unit being installed in West Virginia is known as the sanitary earth-pit privy. Although several sizes are used, that described is the standard unit for a home (Fig. 1). First an earth pit is dug $3\frac{1}{2}$ by $3\frac{1}{2}$ ft in plan and 5 ft deep, and lined with a wooden curbing to prevent caving. A wide, well-tamped earth mound rising 6 in. above the original ground level is constructed around the pit. The floor slab rests upon 4 by $5\frac{3}{4}$-in. concrete sills placed upon the mound around the curbing. The floor is a 4-ft by 4-ft by $2\frac{1}{2}$-in. slab of concrete reinforced with wire mesh, and a rectangular opening is cast diagonally in one corner to receive the seat box. The seat box, or riser, is also of reinforced concrete The seat is of tongue-and-groove lumber and is covered with a self-closing lid. A screened T-shaped vent completes the sanitation unit, which is enclosed in a standard type of frame building. The concrete floor and riser is now the only approved type of construction, although until recently many of the units in West Virginia were of wood, following the same general plan.

Costs vary from county to county owing to differences in quality and price of materials. The average cost of the material in a complete privy, including both sanitation unit and building, is $18. During 1936, when the program was operating with average efficiency, 55,649 units were installed in the state with an average labor cost of 44.6 man-hours per unit. The hourly wage scale during the year was 49 cents. This includes such items as canvassing, local supervision, and clerical hire, as well as labor.

The progress report for the period ending December 31, 1937, listed a total of 179,827 sanitary privies constructed in West Virginia since the program began in December 1933. This provides proper disposal facilities for over 700,000 persons. It is estimated that 55,000 more units will be needed if every rural home in the state is to be served The program has been active in every county, and in several counties it is nearing completion.

VALUE OF RURAL SANITATION PROGRAM

From a work relief standpoint the project is splendid —efficient technical supervision is provided by the sponsor; all the relief money is expended for labor, largely unskilled; and the work is well distributed and no machinery is required. The work has gone forward at amazing speed. In the beginning the program was much ridiculed, but the efficiency with which it was conducted and the results obtained quickly won public approval. Not the least valuable part of the project is the intensive educational program carried out along with the construction. Property owners have contributed material having a value of $3,000,000.

MINING CAMP PROVIDED WITH SANITARY PRIVIES

The most interesting part of the program from a public health engineering standpoint is the effect of the improved sanitation in rural areas upon the incidence of typhoid fever and associated intestinal diseases. Although only four years have elapsed since the program began, a study of the death rates recorded in the Division of Vital Statistics, State Department of Health, supports the belief that the effect has been considerable. From Table I it may be noted that the number of deaths each year from typhoid fever has decreased at a consistent and pronounced rate. Of course many factors not considered here, such as improved milk and water supplies, and improved municipal sewerage, as well as increased protection by immunization, have undoubtedly also played a part in the decrease.

Several years must elapse before we can definitely evaluate the effect of this improved environmental sanitation on the state as a whole, but definite information is now available that filth-borne diseases have been drastically reduced or eliminated in specific rural areas or mining towns. At any rate, West Virginia can now look forward to the day when its typhoid fever death rate will be no higher than the average for the United States, a day that appeared almost hopelessly distant five years ago.

TITICUS DAM, OF THE NEW YORK WATER SUPPLY
This Picture Was Taken in 1898, Three Years After Its Completion. Mr. Ridgway Was in Immediate Charge of the Construction

My Days of Apprenticeship

A Past-President Recalls Some Engineering Experiences of a Half Century Ago

By ROBERT RIDGWAY
PAST-PRESIDENT AND HONORARY MEMBER, AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, NEW YORK, N.Y.

WHEN Robert Ridgway was a boy in Brooklyn, N.Y., the curb-side pump was an important feature of city life, and Trinity Church steeple dominated the New York skyline. Mr. Ridgway has seen many changes, most of which he finds good. But here he turns back the pages to tell a fascinating story of his days of apprenticeship in the profession—of life as a chainman on the Northern Pacific Railroad, and as an assistant engineer on the New Croton Aqueduct. These reminiscences were originally presented in the form of a talk to the Juniors of the Metropolitan Section in New York, N.Y.

IT is only when I consider the changes that have taken place in my own lifetime that I realize how much the world has advanced in but one generation, and it gives me courage to look ahead. When I first saw the light in 1862 in the old city of Brooklyn, it was a primitive town. Its cobblestone pavements were infrequently cleaned—it was an event to see the street-cleaning gang come along. The old wooden pump at the curb was one of the features of the town—although the city had recently been supplied with Ridgewood water—and I was sent many times to get cool water from it. Few realized what danger lurked in this well water. Typhoid fever was regarded more or less as a visitation from God, and the water and milk supplies were not thought to be responsible. Smallpox was rather common, and even cases of yellow fever were not infrequent in and about New York; my father was stricken by it but recovered.

The city was then lighted by gas, which was considered the last word in illumination. The old people liked to recall the good old days, only a little farther back, when they used candles and oil lamps. The highest building in the city of New York measured only six stories, as I recall it, and the steeple of Trinity Church was the dominating feature of the landscape.

Horse-cars traversed the city and in rush hours were loaded as heavily as they could possibly be. When the deep snows came, it was not uncommon for the companies to substitute large sleighs for the cars. The Brooklyn Bridge had not been built, and the only means of communication with the city of New York were the ferries, now abandoned.

A CHAINMAN ON THE NORTHERN PACIFIC

My working life goes back to the spring of 1882, to the prairies of Montana. There I began work as a chainman for the Northern Pacific Railroad, with no background of a formal technical training. This was a great handicap and hardship to me, and I early learned to know what I had missed. If it were my privilege to go through this life again, I would make any reasonable sacrifice to obtain a college education. It is hard enough for a carpenter to make a complicated bit of woodwork when he has a first-class kit of tools, but if he has to make his own tools as he goes along, his difficulties are greatly multiplied.

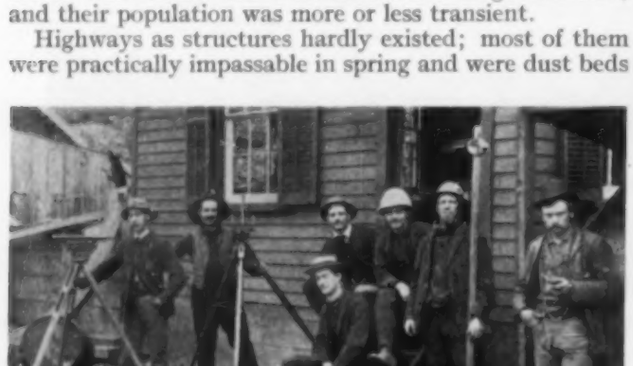
In those days the young man looking for engineering experience was almost forced to seek a job on railroad construction, preferably in the West. There had not been much development in municipal engineering—nothing such as there is today—and the professional field was limited.

The prairies and Rocky Mountain territories were on the frontier, undeveloped, and the Indians were still a menace to settlers. Only six years before I began my surveying work, Custer and his command had been exterminated in the Little Big Horn fight. A cavalry detachment was still considered a necessary part of the outfit of a survey party, although the spirits of the Indians were pretty well crushed, especially in the Northwest. I used to think then that the Indian was a pretty bad citizen, but I have since become convinced that most of the trouble came from the treatment he received, and that his excesses were committed while he was smarting under the wrongs inflicted upon him. The history of our dealings with the red man is not very creditable to us.

Antelope ranged the plains in large numbers, but the vast herds of buffalo had been almost exterminated—the bleaching bones of thousands of them were witness to this waste. They had been slaughtered for their hides, and their carcasses left to the coyotes. This is an example of the brutal disregard of conservation in those days. Most of the present Mountain and Prairie

states were under the territorial form of government, and their population was more or less transient.

Highways as structures hardly existed; most of them were practically impassable in spring and were dust beds



IN FRONT OF THE FIELD OFFICE NEAR OLD CROTON DAM, 1887
Mr. Ridgway Is Seated on the Top Step, Left. At Extreme Right Is One of the Italian Stone Masons Whose Work Is Mentioned in the Article

in summer. Railroads were in their heyday—the great carriers of the nation.

I cannot resist digressing briefly here to speak of the changes of more recent years. Today the automobile for high-class freight and passenger transportation has cut deeply into the railroads' business, and much of the lost traffic, I fear, will not return. Just as the railroads put the canals out of business, so has the modern highway become a serious competitor of the railroads.

A few years ago I was in Korea—now called Chosen—in the office of the managing director of the railroads, which are government owned and controlled. The director was describing the government's plan for developing the railways and adding new lines and extensions. I reminded him of our experience—how in the eighties we extended our railways everywhere; that there was no competition in the shape of highways; how the modern highway has now become a formidable competitor—and I asked him if his country was not facing the same danger. His answer, which set me thinking, was that the government controlled all transportation in Chosen, and that it would coordinate the means—railroad, highway, and rivers—so that all would work together. That is how a centralized government can control transportation and other public utilities.

MONTANA IN THE FRONTIER DAYS

Well, to get back to my Montana experience. My work began at Billings, on the Yellowstone River in Montana territory, a new town existing mostly on paper, which was the headquarters of the Yellowstone Division of the Engineering Department. The main line of the railroad had been graded there, but the rails were 100 miles short (east) of the town, so that the only means of communication with the outside world was by wagon or buckboard—or "Shank's Mare." The town was amply supplied with saloons and gambling "joints" but it was fairly orderly. I believe only one lynching was recorded there—that of a man who had murdered a popular saloon keeper. The committee was so proud of its work that it had a photograph taken of the swinging body, but when someone called attention to the fact that the noose was under the wrong ear, indicating amateurish work, the committee was so chagrined that it destroyed the negative. A few miles out of town there was a graveyard, and most of those buried in it had died "with their boots on." After a victim was interred, it was a touching custom for the mourners to mount their horses and race back to the nearest "gin mill" to drown their sorrow.

This was in 1882. Fifty years later I revisited Billings, which had grown to be a thriving city of 16,000 inhabitants with a high school and college. It was a center of the sugar beet and other agricultural and grazing industries. I was treated very hospitably as an old settler, and was driven in an automobile over the adjacent country, most of it cultivated. It brought back many memories of my youthful days when my imagination looked forward to events in the world which have been far surpassed by actual happenings. There will be much more going on in the next fifty years, but generally speaking the frontier today is in the cities—not on the prairies.

RAILROAD SURVEYS AND CONSTRUCTION—1883

My assignment was to a party which was to make a preliminary survey for a branch line to extend from the main line at Billings to Fort Benton at the headwaters of the Missouri River, about 250 miles to the northwest. The round trip took us from May to November, and with the exception of the two towns mentioned, we did not see a settlement or any semblance of one. For this work I received $40 a month with rations and the privilege of sleeping on the ground in my own blankets—in a tent, of course. The transitman received $80 a month, and I wondered what he could do with it all. Some of my associates who were college graduates tried to discourage me in my resolution to follow engineering. They meant it well I am sure, but my youthful love of adventure, together with my discouraging experiences in seeking employment at home, and a certain amount of obstinacy, caused me to stick to my resolution.

After the survey was made we were sent the following January to the woods south of Lake Superior to locate a line between Superior City and Ashland, a distance of about 60 miles. This was through the primeval forests of northern Wisconsin, before those great virgin stands of pine, hemlock, and hardwoods were leveled. It seemed then that there was pine enough to meet the needs of mankind for many generations to come, but a few years later there was only a barren waste there. The lumbermen had made it. One of our problems, now and in the future, is to make use of what is left, and to find substitutes for the materials our forefathers wasted so prodigally. This is a task for the scientist and the engineer working together.

We worked through the winter on snowshoes, sleeping in tents, running the line with the temperature below zero much of the time. We were all happy and healthy on a diet of baked beans served three times a day. One who has never seen a real primeval forest has no idea of the physical difficulties of the work. Underbrush and fallen trees of giant size interlaced, and it was necessary to climb these barriers, some 12 or 15 ft high, on snowshoes, dragging the chain through 3 ft of snow.

The following summer, construction and the battle with the gnats and mosquitoes began. The grading was light, with moderate cuts and fills. The job was done with pick and shovel and wheelbarrow, and was sublet in small units of a few hundred feet. First the timber on the 100-ft right of way was felled, the best of it saved for ties and trestle timber, and the rest burned. I remember what a task it was to make the contractors dispose of it—the tendency was to bury it in the embankments to save the expense of burning. There were no long-span bridges on my part of the work, but there were numerous trestles of simple design. With the exception

of a few which were 50 or 60 ft in maximum height, they were not very high, and all were of timber, most of it hand hewn. The carpenters were very skillful and made a fine job with their axes—the engineers preferred the hewn to the sawn timber and ties. No masonry was used and no steel except the bolts in the trestles.

I was much interested in seeing these trestle spans raised to position—to see them fit together so nicely—and we all took a great pride in the appearance of the finished structure. It would be difficult now to find a group of carpenters who could fell trees and hew timbers as they did in those days.

THE CALL TO THE NEW CROTON AQUEDUCT

On an August night in 1884, I had retired to my bunk when a messenger came from division headquarters with a telegram from home directing me to report to the chief engineer of the Aqueduct Commissioners of New York City as a leveler. I could not refuse this appointment, but I left camp and my associates there very reluctantly. The next morning I packed all the belongings I could carry on my back and hiked with the messenger to the end of the track, whence we worked our way into town on a hand-car and I left for New York. I thought the work on the aqueduct would last about three years and that I would then return to the West. But fate decreed otherwise; this was the beginning of over 49 years of service with my native city.

Surveys were in progress for the so-called New Croton Aqueduct designed to supplement the old aqueduct, built in 1830–1840. It was designed for a capacity of about 300 mgd as compared with the 80-mgd capacity of the former aqueduct. This new aqueduct was to be in a deep tunnel, differing in that respect from the old one, which followed the contours in cut-and-cover construction. The inlet gatehouse was located in a vast niche cut in the hillside just below the old Croton Dam, which is now submerged 30 ft by the waters behind the New Croton Dam located several miles downstream.

When I started work with the Aqueduct Commission, there were some old engineers who still advocated the use of the water level—a horizontal tube several feet long and filled with water, with a float, equipped with cross hairs, at each end. I believe they used that in laying out the first aqueduct. Because they had used it, these old-timers thought that more accurate results could be obtained with this clumsy instrument, but the younger engineers did not agree with them. We used the wye-level. I remember how carefully the line was leveled from Croton Lake to Central Park, a distance of 35 miles or so, by a very skillful leveling party headed by Assistant Engineer Moore, an old-time western mining engineer. Even then, Charles S. Gowen, M. Am. Soc. C.E., my division engineer, was not satisfied that there had not been some errors, and when we were assigned to the construction he told me to run over the line of his division using assumed elevations. Then, as I touched on the bench marks along the line, he would turn them back to the actual elevations. I remember his coming out one day just as we touched on one of the benches $2^1/_2$ miles from the start. We sat down together and worked out the elevation. When we had finished he turned to me and said, "Ridgway, you are 0.003 ft out," as if that were a serious error. He was an excellent man to work under. He went on the theory that in tunnels especially, where there is nothing to tell an engineer whether he is right or wrong, the correct principle to observe is to consider oneself wrong until proved right. I have never forgotten this good advice.

MR. RIDGWAY (IN BOWLER) AND THREE OF HIS SURVEYORS—JEROME PARK RESERVOIR, ABOUT 1895

Those were the days when our present methods were sniffed at by conservative surveyors as new-fangled notions. While some progressive men advocated and used the stadia method, it was looked upon by the elder statesmen with more or less suspicion. To survey a large area of land was quite a task. The transit and tape and the level and rod were the standard equipment. What a change to the present methods of aeroplane and stadia surveying!

Everyone has heard of the tunnel cross-section machine, popularly called the "Sunflower," but probably few know how it got its name. One of the division engineers of the Aqueduct Commission, Alfred Craven, M. Am. Soc. C.E., afterwards chief engineer of the Public Service Commission, was an excellent surveyor and had had much experience working in the deep silver mines in Nevada. He devised the cross-section machine, the disk or protractor of which was of varnished pine wood. The varnish being yellow and the radiating lines of the protractor being black, it had the appearance of a sunflower, and that became its popular name. Later the instrument makers substituted a metal disk for the yellow wooden disk, but the name stuck.

The actual construction work of the aqueduct was begun early in 1885, and I was assigned to the first division, under Mr. Gowen. This division extended from Shaft 0 at Croton Lake to and including Shaft 4, located a few miles east of Ossining (or Sing Sing, as it was then called). The sinking of the shafts was a novelty to me, and I can still remember the excitement I got out of the twirling buckets. In those days they used the old fashioned cable, which permitted the bucket to twirl

BRANCHES OF THE OLD AND NEW CROTON AQUEDUCTS, AT JEROME PARK RESERVOIR
The New Aqueduct Itself Is in Tunnel at This Point, 115 Ft Below the Surface

around like a top. We rode on the rim of the bucket. A great many accidents occurred in those days. My recollection is that a hundred men were killed north of the Harlem River. Among them was my superior, Assistant Engineer R. E. Morris, a promising young engineer. Human life was held much cheaper then than it is today. The killing of a man was an incident in a day's work, and with the exception of the victim's relations and close friends, nobody was much disturbed by it.

The driving of the tunnels was also interesting work. We had a manager—of the contractor's—who was Scotch and had red hair, and who, though competent, was as obstinate as anyone could be. Electricity had not come to be used for lighting tunnels, and this man chose to use kerosene burned in naked torches for the purpose. In consequence, the tunnel was always filled with smoke, and I imagine that I had a thick lining of soot in my lungs before the work was through. I imagine too that many workers died eventually as a result of breathing rock dust and smoke. The air was so thick that we could not see to run our lines with safety, and then there would be a row to make the contractor clear out the tunnel. Sometimes we would have to refuse to give the lines until he cleared the tunnel. He would continue as far as he dared without the lines and then reluctantly give way.

Usually there was a lull in the work after pay day because a large percentage of the laborers took refuge in drink, perhaps to forget their troubles. They would be found lying along the roads and in the fields a day or so before work would be resumed in normal fashion. The "good old days" were not all that we think they were. Being rather old fashioned myself, I think that some of the younger engineers of today have not been trained to take responsibility as they had to do then, but in most matters affecting health and progress the present is way ahead of the past.

BUILDERS OF THE CATSKILL PROJECT—THE THIRD MAJOR STEP IN THE DEVELOPMENT OF THE WATER SUPPLY OF THE CITY OF NEW YORK

Left to Right: Department Engineers C. E. Davis and M. H. Smith; Chief Engineer J. Waldo Smith; and Department Engineer Robert Ridgway

TROUBLE ON THE AQUEDUCT

The tunneling went along fairly well until work was begun on the masonry lining, and then real trouble started. With few exceptions the aqueduct contractors shirked their obligations, and it was a constant fight to force compliance with the specifications. Meanwhile I had been made an assistant engineer and as such had been given charge of the headworks and of Shafts 0 and 1. The fight was in regard to the lining of the main tunnel. In our troubles we assistant engineers had the unswerving support of Division Engineers Gowen and Craven.

Cement was skimped in the mortar for the brick lining. Some of the rings of brick, especially in the key, were omitted; much of the stone backing of the brick lining was placed dry, utterly devoid of any mortar, and large cavities without filling of any kind were left over the brick arch. Some of the inspectors were unreliable, and it was necessary for the engineer to be in the tunnel night and day. It was a very discouraging situation and at times seemed hopeless. Orders of the engineers were disregarded and the situation became so bad that Mr. Gowen ordered the work stopped in the heading of Shaft 0. On the contractor's refusal to do so, I was directed to estimate no more work for payment.

That brought about a crisis. The contractor preferred charges against Gowen and Craven before the Commission, for interference with the work, and it looked as though they might be removed. But the scandalous conditions led to an investigation by a legislative committee. New Commissioners were appointed who, after a thorough investigation, gave new authority and support to the engineers who had stood against the scamp work. The contractors were required to repair the work. Much of the masonry was taken out and replaced, and the dry stone backing was repaired by grouting. In the construction of the dams which followed this work, however, the quality of the masonry was such that no engineer could be ashamed of it.

All the earlier dams of the Croton system were built of rubble masonry faced with cut stone or ashlar. My experience in such work was on the Titicus Dam near Purdy's Station, constructed between 1890 and 1895, which has a maximum height of 130 ft. I remember with what care the rock bottom was prepared, carefully washed, and all loose fragments removed. The mortar was thoroughly mixed. All stones were washed before placing, and especial attention was given to their bedding and to the breaking of vertical and horizontal joints. The face stones were set normal to the latter, and as no wedges were permitted to be used, it was a work of skill to get them exactly in place. The masons were all friends of mine and I question if their like can be found today, because concrete has replaced the old type of masonry for dams—it is cheaper and can be placed more rapidly. I recall that in the month of best progress the contractor placed 6,000 cu yd of rubble masonry. We thought it was fine, but today they are placing more than that amount of concrete in one day at Grand Coulee. What a jump!

IN RETROSPECT

As I look back over the years that have passed since my engineering service began, the faces of those with whom I have been associated come before me. There is an old saying that character is formed by association. I realize what these associations have meant to me, and I am thankful for the opportunities they gave me to do something useful. A great many of these associates have gone to their reward. I think with gratitude of the assistance they gave me, and am grateful for their criticism, not always kindly, of which I had my share. There were and are so many of these helpful friends and associates that it would be impossible to name them all, but I feel I should mention a few: William Barclay Parsons, Hon. M. Am. Soc. C.E., who designed, and whose ability and character carried through to completion, the first rapid transit subway in New York City; Alfred Craven, who so ably supervised the design and building of the second subway project in New York City—who knew no physical or moral fear, and who was one of those who stood so valiantly against the attempt to do scamp work on the Croton Aqueduct; and that modest, unselfish, and lovable man, that able engineer of broad vision, that wonderful executive, J. Waldo Smith, Hon. M. Am. Soc. C.E., who was responsible more than any other one man for bringing to New York City the great blessing of Catskill water. They have all laid down their burdens and have gone to their rest.

Use of Aerial Mapping in Soil Conservation

By W. C. LOWDERMILK

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WHEN the Soil Conservation Service began its nation-wide program in 1933, it was confronted with an almost complete lack of suitable large-scale maps. Aerial photogrammetry filled the need to perfection, says Dr. Lowdermilk, and to date the Service has mapped about 400,000 sq miles from the air. The accompanying article, after explaining the conservation program in sufficient detail to clarify its map requirements, describes briefly the mapping methods and standards now in use, and lists a number of the improvements that have been made in aerial mapping technique in the course of this work. The article is abridged from a paper on the program of the Surveying and Mapping Division at the 1938 Annual Convention.

RECOGNITION must be given aerial photographic mapping for its part in the speedy development of the national soil conservation program. When this conservation work was initiated in 1933, large-scale and accurate maps—tens of thousands of them—became necessary. Information about the land was required in sufficient detail not only for general watershed plans of land treatment but for individual farm plans, field by field. It had to be gathered in a short time, and recorded for ready reference in all its details. Traverse surveys would have been woefully inadequate as regards immediate availability and economy, but aerial photography filled the need magnificently.

It is not the purpose of this paper to describe the general uses of photogrammetry, but rather to indicate how it serves the work of soil conservation. Let us first, therefore, review briefly the conservation program, to gain a clearer concept of its map requirements.

The program of the Soil Conservation Service aims to meet the needs and adaptabilities of the land in the combined interests of soil and water conservation and flood control. The over-all plan for a given drainage basin takes into consideration the climate; the general characteristics of soils, with special reference to their susceptibility to erosion under clean tilled crops and other uses; slope characteristics and land classification; hydrological characteristics of the area; the prevailing type of farming; and the economic status of the farming population. On the basis of such information a master plan is prepared which sets up land-slope classifications, upper limits of safe cultivation, suitable rotations, spacing and grade of terraces, types of terrace outlets and waterways, desirable wild life development, land-use adjustments, runoff retardation, and such other prescriptions for soil and water conservation as may be needed.

In turn the detailed farm plan represents an adjustment of the over-all drainage plan to a specific farm. Field boundaries may be changed, rotations begun, strip cropping followed, terraces laid out, outlet channels prepared, and gullies controlled. The farm plan is a compromise between the over-all drainage master plan and limitations imposed upon the farm by size, topography, soil, and erosion, as well as by the requirements of the farmer. Within the five-year agreement made with cooperating farmers, the farm plan is brought by stages as nearly as possible to fit the needs of soil conservation.

To meet the needs for both basin-wide and farm-size plans, an inventory of the physical land factors, involving four features, was developed. They were (1) soil type, (2) land slope gradient, (3) degree of erosion, and (4) present land use. "Soil type" includes a description of the texture, depth, and character of the topsoil; depth and character of the subsoil; and usually a description of the underlying parent material, as well as of the significant chemical and biological properties.

Slope gradient and length likewise are important factors in land-use adjustments. Detailed topographic data to show slope gradients in contours of 6-in. or 12-in. intervals would be ideal in the adjustment of land use to slopes, but such detail in topographic maps is not practicable for large-scale operations. Recognition that slope and soil characteristics are interrelated provides, however, a satisfactory basis for a land-slope classification. A definite correlation exists between slope gradient and developmental characteristics in mature soils. Every soil has ranges of slope within which its permanency will remain practically the same under its natural cover; each soil will exhibit, notwithstanding, special responses to erosion when cleared of natural vegetation and subjected to cultivation and other uses. The correlations between ranges of slope and soil characteristics are evaluated at the outset of each survey by establishing five or more slope-soil groups for use in field mapping. The dominant or prevailing gradient in terms of per cent of slope is indicated on the map in each delineated area.

Degree of erosion, moreover, is given several classifications—sheet erosion, gully erosion, and wind erosion—and is designated in terms of the fraction of the original top soil removed by erosion and by the number and depth of gullies per acre. A series of symbols designates the classifications of sheet erosion and the presence or absence of gullies and their depth and number. For wind erosion, symbols designate degree of removal of the top soil as well as the accumulations of sandy hummocks.

Lastly, "status of present land use" is self-explanatory. Symbols designate the condition of mapped units, whether in a crop, whether abandoned after cultivation, or whether in pasture or forest.

As a preliminary step in determining the land-use classes into which the various delineated areas may fall, a table is prepared giving the suggested use for each soil type, for various conditions of slope and erosion. Such a table is based on notes taken during the progress of the survey, on information accumulated by all research agencies applicable to conditions, on data from conferences with farmers in the area, and on results of programs on land of similar character.

ERODED FIELDS AS SEEN FROM THE AIR—MONONA COUNTY, IOWA

Each of the Light Spots Indicates an Eroded Area

Land-use classes as related to physical factors are expressed by symbols indicating the most intensive type of utilization that can be recommended for each delineated area, based solely on the physical factors mapped. The area of the land unit delineated on the map may vary widely. It represents slope facets of similar physical characteristics. In the Great Plains, the mapping unit may be as large as, or larger than a section, whereas in

AERIAL PHOTOGRAPH WITH FIELD NOTES ON SOIL TYPE, SLOPE, AND EROSION

These Data Later Become a Part of the Planimetric Map That Is Used for Developing a Plan of Land Use

broken topography it may be a small field of a few acres.

The land-use classes as applied to agricultural lands are as follows: *Class A*. Suitable for the production of cultivated crops without erosion-control practices other than good methods of farming. *Class B*. Suited for the production of clean-tilled crops, but requiring simple erosion-control measures. *Class BB*. Suited to clean-tilled crops, but requiring more intensive measures of erosion control than lands in Class B. *Class C*. Not suited to the production of clean-tilled crops, but suitable for close-growing crops if grown in such a manner as to provide adequate cover throughout the critical erosion periods. *Class D*. Suited only for permanent cover. Any of these classes may be subdivided to show whatever additional information may be desired.

Aerial photographs, enlarged to a scale of 4, 8, or 12 in. to the mile, are used by the Soil Conservation Service in detailed conservation surveys for recording and delineating the four physical factors of land classification, and for erosion-control plans for farms, for other lands under treatment, and for flood control surveys. The aerial photographs are used for all project areas, for as many of the CCC work areas as can be served, for large work areas on government lands, for the location of experiment stations, and for reservoir surveys, as in the case of Lake Mead, where accurate topographic maps are required.

Thus far the Service has mapped from the air about 400,000 sq miles of land. This large area together with about 860,000 miles photographed by the Agricultural Adjustment Administration, and another 140,000 sq miles by the Forest Service, equals a grand total of 1,400,000 sq miles. Fully 46 per cent of the continental United States has been photographed from the air, as well as all Puerto Rico. The hopes of photogrammetrists are rapidly being realized.

These photographic records are valuable in giving a factual and bird's-eye view of the land and its condition. Moreover, they will be invaluable in future years as a basis for comparing land conditions from time to time, and for following trends in land use.

PHOTOGRAPHY, FIELD WORK, AND MAP MAKING

The original photographs are usually taken at a scale of 1:20,000, or about 3.17 in. to the mile. The altitude of flight of the plane is determined by the average elevation of the country to be photographed and the focal length of the lens. A lens with a focal length of not less than $8^1/_4$ in. is generally used, and requires a photographic altitude of approximately 13,750 ft. Enlargements to the desired scale, such as 4 in. to the mile and larger, are made from the negatives exposed at this altitude and are used as a base for the conservation surveys.

Before any field work is done, the photographs are examined under the stereoscope and the exact pattern of the drainage is delineated in blue. At the same time match lines are drawn in a distinctive color to indicate the area to be mapped for land-use factors on each photograph. With these data already on the print, the conservation surveyor can devote his time to observing and recording the condition of the land, field by field. The four characteristics of the land are designated by symbols, and their boundaries marked by solid lines.

During the course of these operations, the necessary ground control for a planimetric map of the project area is established, and accurate planimetric maps are constructed by recognized photogrammetric methods.

When the conservation survey is completed and the field data sheets are correlated with previous surveys, the field sheets or photographs are placed in special projectors, designed to reflect adjustments in scale. The boundaries of the survey on the base photograph are transferred to the planimetric maps. In the field, survey boundaries are delineated in relation to objects that are visible on the photographs, and these boundaries when transferred in this manner appear in their true positions on the corrected map. The planimetric map, rather than the photograph with its scale distortions, is suitable for publication and use.

The maps are reproduced in sheets 14 by 20 in., each sheet representing 10.5 sq miles. Four colors are used: the culture in black, drainage in blue, conservation survey boundaries in brown, and existing land use in green. In this form, with legend, and accompanied by a printed report, the maps are available to land-planning and land-use agencies, and to technicians and geographers.

These maps also serve for making the flood control surveys called for under the Omnibus Flood Control Act. By this Act the Department of Agriculture was made responsible for the land-use phases of flood control, supplementing downstream engineering works, and the maps are indispensable to the new activity. They will also serve for the evaluation of essential information on a watershed basis. Infiltration capacities of soils, slopes under different land use, silt production areas, and rainfall patterns may be applied to the base drainage map for evaluation in terms of storm runoff and flood-flow accumulation.

Since the first aerial surveys for soil conservation work in 1933, many rapid advances have been made in the photogrammetric art. For example, to make the necessary photographic enlargements accurately, economically, and rapidly, it was necessary to adapt standard commercial photographic equipment to do the work. Such improvements included designing, building, and installing new and improved adaptors for aerial roll films, and also the development of roll film holders, slow-motion adjustments and calibrations. As the standard commercial equipment did not provide proper lamp-house

ventilation for such work, it was necessary to install suction fans on the top of each lamp house to prevent the heat of the lamps from damaging the film.

Other improvements and adaptations of standard equipment in general commercial use include: (1) a special contact printer, fitted with 9 lamps and vertical adjustments and ventilated by a suction fan; (2) an adjustible reflector, mounted on two stands at the back of the copy camera; (3) the slotted templet method of extending radial control triangulation. This method reduces the amount of ground control required, and is one of the most outstanding recent developments in photogrammetry. Improvements in templet material and in accurate radial slot cutters have further increased efficiency. A new templet stud of tenite, non-corrodible, and causing less friction, has replaced the steel studs.

Research is in progress to develop methods and equipment to use the U. S. Coast and Geodetic Survey 9-lens photographs for control purposes. Planimeters and rotometers used to determine areas are being replaced by a method of weighing the paper cut out along boundary lines.

Accurate delineation of information on photographs for planimetric maps requires the use of stereoscopes. The original and costly type of mirror stereoscope has been replaced by a comparatively inexpensive dioptric prism. Further improvement of stereoscopes is under way to allow for correction for a difference in the scale of two photographs under view.

To replace the two steps in transferring information from photographs, first to celluloid plates, then to the map, there has been developed a special projector which provides for direct transfer of information from the photograph to the metal-backed map drawing paper. It has been in use by the Soil Conservation Service for two years.

Uniform lettering has been achieved by the floating on of printed lettering and legend symbols. Numerous other pieces of laboratory equipment such as washers, dryers, and tanks have been designed and put into use.

MANY GOVERNMENT AGENCIES SERVED

Aerial photography serves other activities of the government as well as it does those of the Soil Conservation Service. The Forest Service for a number of years has been using aerial photography to facilitate the purchase of lands under the Weeks Law of 1911. The bird's-eye view, which supplies an accurate description of the lands under consideration, is permanently recorded and safeguards government interests in establishing sound conservative values for such lands.

The Agricultural Adjustment Administration has likewise found that aerial photography facilitates its nation-wide program of agricultural conservation. To supply the basis for making payments to farmers for diverting acreages from soil-depleting to soil-conserving crops, and for carrying out approved soil-building practices, a rapid, accurate, and economical method was needed. The aerial photograph supplied this need.

The standards for aerial mapping were worked out by the Land Policy Committee of the Department of Agriculture to meet the needs of a number of government agencies. They are: scale, 1:20,000; print overlap, 65 per cent in line of flight; strip overlap, 30 per cent; flight direction, north-south or east-west; tilt, maximum 1 deg average for entire project; crabbing, maximum of 10 per cent; scale accuracy, within 5 per cent.

These standards were adopted by the several services, and arrangements are in force to make the photographs available to any using agency. The large total area photographed by all the agencies together makes available to any one a vast photographic record. Most of the photographing is being done by the following agencies: U. S. Soil Conservation Service; Agricultural Adjustment Administration; U.S. War Department; U.S. Forest Service; U.S. Geological Survey; Tennessee Valley Authority; and commercial companies.

Of special interest to western engineers is the mapping of the Boulder reservoir (Lake Mead) to furnish the

EROSION-CONTROL PRACTICE—SPARTANBURG COUNTY, S.C.
Strip Rotation of Cotton and Small Grain—Small Grain Followed by Annual Lespedeza. Width of Strips Is One Terrace Interval

basis of a progressive record of the rate of silting. This reservoir is located in some of the most precipitous, arid, and difficult topography in the world, practically without roads or rapid ways of getting about. When the gates of the dam were closed on February 1, 1935, and the impounding of water in the reservoir began, the only possible way of mapping the area ahead of the rising water was by aerial photography. The work is well described by Leon T. Eliel in *Photogrammetric Engineering* for January, February, and March 1937.

The contract called for the delivery of a topographic map at a scale of 1 in. equals 1,000 ft, with a contour interval of 10 ft. This map was to extend up to the 1,400-ft contour, or 170 ft above the normal elevation of the lake. The job involved exploratory photography, the establishing of controls, and the taking of the aerial photographs before the rising lake level obliterated the ground features of the reservoir basin; all this required speed and skill of the highest order. The Coast and Geodetic Survey furnished reference points for ground control in triangulation and lines of levels of first-order accuracy. The excellent cooperation of the Reclamation Service and the Coast and Geodetic Survey was of material assistance to the Soil Conservation Service in providing the contractor with certain stipulated field information.

The map was compiled by the latest methods, utilizing the stereoplanograph. Supplementing the contract for the topographic map, another award was granted which called for aerial photographs giving complete coverage of the water's edge as the lake rose, taken at successive 20-ft intervals as measured at the dam. This photography established these contours precisely without being subject to accumulated errors, and contributed to the accuracy of the map.

This job in its technical features, in the adventures of establishing ground control, in the two boat trips through the Colorado gorge to cross-section the channel under water, in the use of radio by the river party, and in the effective cooperation of the several interested agencies, will stand as one of the masterpieces of photogrammetry.

Status of Sewage Disposal in Western States

By DANA E. KEPNER

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IN the far western states, says Mr. Kepner, the building of truly modern sewage treatment plants dates in general from the advent of PWA. The relatively few plants of earlier date were mostly limited to primary treatment; some of them were poorly designed and most of them were poorly operated. There is need today for many more new plants—and equal need, Mr. Kepner stresses, for men who know how to run them. He explains quite definitely how such men can be developed. This article is abridged from a paper on the program of the Sanitary Engineering Division at the Salt Lake City Convention of the Society.

UNTIL a decade ago, sewage disposal in the 11 westernmost states consisted, in almost every instance, of direct discharge, untreated, into the most convenient watercourse. Although prior to 1920 several of the principal cities had already grown to nearly their present size, and thousands of smaller cities and towns boasted populations of from one to fifteen thousand, their scattered locations permitted them to make use of such simple methods without much apparent harm to each other. True, streams were being defiled—but it was generally acknowledged that even without contamination by untreated municipal sewage, their waters would not be safe for domestic use without purification in some degree. Also, except in rare instances, the flow of the streams provided sufficient dilution to prevent offense to sight and smell.

About 1920, the more heavily populated western states became "sanitation conscious." They employed sanitary engineers in their health departments, many through the initial cooperation of the Rockefeller Foundation, and through suggestion and encouragement from the U. S. Public Health Service.

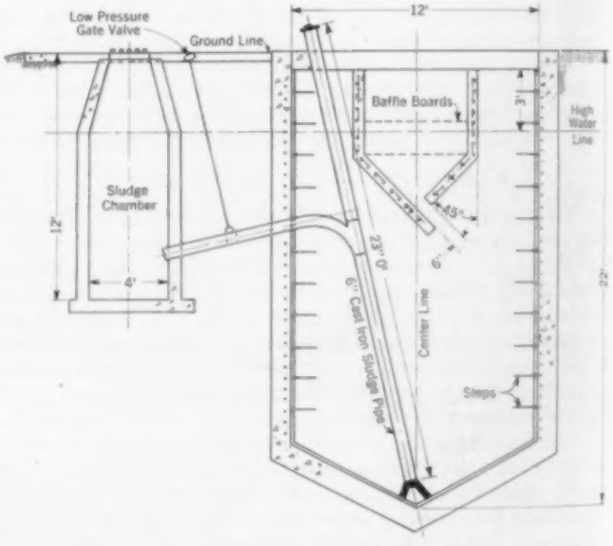
Let us picture for a moment the conditions encountered by these first state sanitary engineers. Here were hundreds of cities and towns, scattered many miles apart, enjoying with reckless abandon their rapid growth. Each state had a record of typhoid epidemics, many waterborne. In the larger and more forward-looking communities adequate means had been taken to provide safe domestic water supplies; practically none, however, had given serious thought to sewage treatment. In hundreds of the smaller communities, in fact, the belief was still current that running water purifies itself in flowing 100 ft in the average stream.

TREATMENT PLANT AT ALBUQUERQUE, N. MEX.—TWO ROWS OF SEPTIC TANKS, WITH SLUDGE AND SCUM STORAGE TANKS BETWEEN

Typical of the Plants That Met the Requirements of Western States Only a Few Years Ago, It Is Soon to Be Superseded by a Modern Installation

Obviously the work of these early state sanitary engineers was largely that of education. And like the people generally, they directed their efforts first to the field of water supply and purification, for it was there they could do most with their limited funds and personnel in decreasing the incidence of water-borne diseases.

Prior to the coming of state sanitary engineers a few small sewage treatment plants had been built, largely as a result of high-pressure salesmanship by self-styled experts. Many of these early consultants were local men with meager knowledge of sanitation and even less experience. To them the septic tank provided good sewage treatment and the Imhoff tank was virtually the essence of perfection. Secondary treatment was practically unheard of. One such "consultant" sold his services to a dozen or more towns in Colorado, designing and supervising construction of what he called Imhoff tanks, but which no self-respecting engineer would call by that name today. Generally these tanks were designed with



ONE OF THE SO-CALLED IMHOFF TANKS "SOLD" TO MANY COLORADO TOWNS PRIOR TO 1924

This Particular Unit Was Built for a Town of 1,200. Capacity of Settling Compartment Was Only 1,800 Gal, Representing a Theoretical Detention Time of About 10 Minutes at Peak Flows

a detention period in the flowing-through compartment of from 20 to 30 minutes, and the capacity of their digestion compartments seldom exceeded one cubic foot per capita. Their proponent claimed that they would never require any attention; the solids would be "completely eaten up by the bugs." In a few years, through this encouraged lack of attention, the tanks became utterly worthless. It may be noted that the proponent of this

type of tank timed his rather hurried exodus from Colorado almost to a day with the arrival of the State Health Board's first sanitary engineer. He has never returned.

Many plants of this and other similarly inadequate types dot the landscape in the western states. They are tolerated largely because, even without treatment, the sewage does not grossly pollute the receiving watercourse or seriously interfere with water purification plants downstream.

This picture of the early days of sanitation in the western states would not be complete without reference to a few conscientious, studious, and energetic civil engineers who designed and built a limited number of Imhoff tanks, Doten tanks, and other types of sewage treatment plants which even today are producing reasonably satisfactory primary effluents. To these men, thoroughly competent in their day, much credit is due.

USE OF CONTAMINATED WATER FOR IRRIGATION

At this point it is well to bring out one problem in sewage disposal, rather common to the Far West, which does not arise in the Middle West and the East. Practically every river and stream in the far western states has been tapped from one to a hundred times with irrigation ditches. Sewage contamination in these streams is no detriment to agriculture as far as the growing of crops is concerned. However, it was early recognized that fruits and vegetables consumed in the raw state, if irrigated with water containing domestic sewage, serve as a medium for the dissemination of water-borne diseases. Sporadic cases of typhoid fever, dysentery, and other intestinal ailments that could not be traced to water, milk, or other food supplies, came to be recognized as having been caused by the eating of such fruits and vegetables. This presented a rather serious problem. Irrigation water in the arid regions is virtually liquid gold, and to prohibit the use of it from streams receiving untreated sewage would give rise to many lawsuits—which might possibly be decided adversely from the standpoint of public health.

A MODERN PLANT AT GREELEY, COLO. (BUILT IN 1936)
The Installation Includes Screens and Shredders, Settling Tanks, Chemical Feeders, Flocculator, and Digestion Tank

During the last ten years there have been many outbreaks of a mild form of what is termed "summer dysentery," throughout the Rocky Mountain region. This dysentery is of short duration and is rarely serious, but the physical discomfort to its victims is extreme. Many an innocent water supply has been accused of being responsible for such epidemics; but thorough investigation has shown in every case that neither water nor milk was the cause. By the process of elimination, raw fruits and vegetables irrigated with sewage-laden water have been accused, and probably rightly. So thoroughly convinced of this is the State Health Department of Colorado that in setting up its requirements for the treatment of Denver's sewage, it insisted upon effluent filters to remove amoeba. (Chlorination of the effluent, which was also required, is considered adequate to kill bacteria, but not amoeba.)

THE NEW PLANT AT BRUSH, COLO., FEATURES A MODIFIED IMHOFF DESIGN WITH PROVISION FOR COLLECTING AND BURNING THE GAS

PWA GIVES IMPETUS TO BUILDING OF TREATMENT WORKS

The building of modern sewage treatment plants worthy of the name, in the western states, may be said to have started with the advent of the Public Works Administration, perhaps with the exception of California, where it got under way some years earlier. There had been a growing realization of the need for sewage treatment in many cities and towns, but the difficulty of financing such projects, particularly in the dark depression years, had thwarted progress.

The first modern sewage treatment plant constructed under the PWA in Colorado, and probably the first in any far western state was that at Boulder. Farmers downstream from this city had been suffering for several years from offensive odors caused by the pollution of Boulder Creek through the discharge of Boulder's worse-than-raw sewage. It is termed "worse-than-raw" because the city had constructed several long narrow lagoons, through which the sewage flowed in series prior to discharge into the stream. These lagoons became virtually septic tanks, and since sludge was seldom removed, the effluent was far worse in B.O.D. than the influent. The injured farmers threatened to bring an injunction suit to require the city to construct a modern sewage treatment plant, and this occurred just when the PWA was being started. This is believed to be the only municipal sewage plant in the western states built as a result of a threatened injunction suit. However, it served as an excellent object lesson to other municipalities.

It was the 30 per cent grant in aid offered by PWA—later raised to 45 per cent—that provided just the stimulus needed to start an active campaign for sewage treatment works in Colorado and to a lesser extent in the other western states. Coincident with this assistance came financial help from the CWA and WPA, permitting widespread sanitary surveys of streams, from which the degree of treatment required for the major cities and towns throughout the region was determined. It is hoped that through some definite federal program of

assistance, this work can be carried in the near future to its logical conclusion. Meanwhile, however, through the new life recently given to the PWA, modern sewage treatment plants continue to be built in the western part of the country.

Through the kindness of the respective state health departments and their sanitary engineers, the following statistics of sewage treatment in Colorado, Wyoming,

RELIEF LABOR FROM WPA WAS USED THROUGHOUT IN BUILDING THIS PLANT AT BERTHOUD, COLO.

The Imhoff Tank Has Stone "Gravity" Walls. Sprinkling Filter in Background

New Mexico, Utah, Idaho, and Montana have been supplied to the writer. No doubt these statistics indicate the trend in other western states, the more populous states having naturally acquired a greater number of plants than the others.

In Colorado 18 cities and towns have sewage treatment plants providing either complete or intermediate treatment. Of these, 6 comprise Imhoff tanks with sprinkling filters; 3 have sedimentation with separate sludge digestion and trickling filters; 3 have seasonal chemical precipitation only; one has seasonal chemical precipitation with effluent filtration; 2 have septic tanks with subsurface seepage; 2 have septic tanks with sand filtration; and one has a septic tank with chlorination. Also in Colorado there are 26 cities and towns with sewage treatment plants providing primary treatment. Of these, 13 have septic tanks, 4 have sedimentation with separate sludge digestion, and 9 have Imhoff tanks. Thus in Colorado there are 44 municipal sewage treatment plants in some 105 cities and towns having sanitary sewer systems. Probably 12 more plants will be built during the current period of operation of the PWA and WPA.

In Wyoming, there are some 41 cities and towns having sanitary sewer systems, of which 13 have primary treatment (3 with Imhoff tanks and 10 with septic tanks). No plants providing intermediate or complete treatment are reported.

In New Mexico, of some 75 cities and towns having sanitary sewers, 41 have treatment plants, of which 6 provide complete treatment.

Idaho reports construction of but two sewage treatment plants in recent years, one providing intermediate and the other complete treatment. Five new plants are planned with present PWA funds.

In Montana 79 cities and towns are reported as having sanitary sewer systems, of which 48 have treatment plants. Of these, 42 have septic tanks, 6 being followed by sand filtration; 3 have Imhoff tanks; and 3 have plain settling basins with separate sludge digestion.

In Utah, of the 46 cities and towns reported as having sanitary sewers, 21 have treatment plants, all being septic tanks, two of which are followed by chlorination.

This review of the present status of sewage disposal in the western states leads up to the question of what their further needs are in this direction. The answer is twofold. In the first place, there is need for many additional well-designed treatment plants, following an orderly program of stream-pollution control. In the second place, there is need for competent plant operation.

IMPORTANCE OF INTELLIGENT OPERATION

When a city builds a well-designed sewage treatment plant the battle is only half won. Even the best of plants is of little value if operated improperly. Unfortunately, the trend in the past has been to turn over the operation to untrained and generally incompetent persons. From the simplest plant to the most complex, intelligent operation is important—if it was important to build the plant at all.

It is encouraging to note a trend among the larger consulting firms of the Middle West that are designing sewage treatment plants in the western states, to include in their contracts the supervision of operation of the plant for a period of from six months to a year after completion. It is believed that in the near future state health departments may make such a clause compulsory. The benefits of such a procedure are evident. In the first place, it helps the consulting engineer himself by permitting him to study, at no particular expense, the operation of the plant he has designed, thus better fitting him for the next project. In the second place, it materially aids the city in getting proper operation of its plant. Competent plant operators are scarce indeed, and most cities must break in new, inexperienced employees. Such men, if intelligent and energetic, can make good operators, but they need the instruction which only the consulting engineer can provide.

Incidentally, if consulting engineers are required to supervise operation of their plants for a period following completion, probably fewer hastily designed and unworkable plants will be built. This point is stressed because in recent years several sewage treatment plants in the western states have been virtually designed for the consulting engineer by an equipment manufacturer. Several of these plants involved considerable mechanical equipment and were designed to operate on patented processes that were not necessarily best suited to local conditions. One such plant, virtually loaded down with unnecessary equipment, has proved so difficult and expensive to operate that it has been a white elephant to the city that built it. Another plant, built about three years ago, has suffered so badly from corrosion by hydrogen sulfide, the result of both poor design and poor operation, that it has been practically abandoned. Had the engineers who designed these plants been required, by their contracts, to supervise operation for a year, they would have given far more thought to proper design, or in any event they would have corrected some of the worst defects in the early stages of operation.

Many cities and towns in the western states are now exercising due caution in the employment of competent consulting engineeers to design their treatment plants. Some, however, should still be counseled on the importance of selecting firms with knowledge and experience adequate to enable them to design a plant of the proper type for the particular conditions to be encountered—as regards the quality of the sewage, the nature of the watercourse into which the effluent is to be discharged, and the possible lack of skilled operation.

ENGINEERS' NOTEBOOK

This department, designed to contain ingenious suggestions and practical data from engineers both young and old, should prove helpful in the solution of many troublesome problems. Reprints of the complete department, 8½ by 11 in., suitable for binding in loose-leaf style, are available each month at 15 cents a copy.

A Compact Hydraulic Laboratory

By WILLIAM MORTON, JUN. AM. SOC. C.E.

JUNIOR ENGINEER, STATE DEPARTMENT OF CONSERVATION AND DEVELOPMENT, UNIVERSITY OF WASHINGTON HYDRAULICS LABORATORY, SEATTLE, WASH.

THERE are many flood control problems in the western part of the state of Washington, each of which is rather small compared to the comprehensive projects in some of the middle and eastern states. Nevertheless, they are excellent examples for laboratory research to develop the most economical and efficient improvements, and we are hoping that a thorough model study will reveal designs which will bring these projects within the financial reach of the local communities.

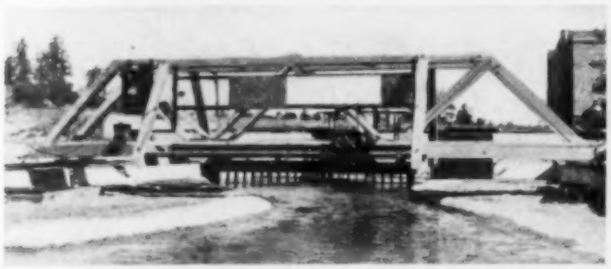


FIG. 1. MOVABLE BRIDGE, WITH CURRENT-METER CONTROL PANEL AND PROFILOGRAPH

Facilities for such studies have been developed at the University of Washington, in Seattle, involving several unusual features, among which is a movable observation bridge, a full-scale profilograph, a midget current-meter control panel, and an automatic sand feeder. These will be applied to models of the movable-bed type.

Each model project will be operated as a unit in an outdoor flume, 20 ft by 80 ft, with this equipment so arranged that it can be fitted to any of several flumes for various projects. This interchange of equipment allows a schedule of research wherein operations can be separated from construction. In addition to the feature of flexibility, the coordination and development of this set-up has resulted in relieving observers of many tedious tasks that usually accompany hydraulic research operations.

Hydraulic models in general require a coordinate system for the three dimensions within the model region, and dimensions should be obtainable by mechanical methods, rather than by manual survey. However, any device for locating points should be subject to convenient check by precision survey instruments. The mechanical means available in our laboratory for locating points in the model region is a movable observation bridge (Fig. 1) carrying a profilograph. This bridge moves on flanged wheels over an accurately alined 16-lb rail, which is anchored to the top of the flume side walls with adjustable anchor straps. The bridge will be moved and spotted by a geared hand-wheel drive not shown in these views.

The profilograph, Fig. 2, has a vertical and horizontal motion through gearing engaged to a steel rack, which allows positive movements to exact points in space. This instrument may be used to trace topography in the movable sand bed of the model, which is plotted directly on the drawing board above; or it may be used to hold a midget current meter, or Bentzel velocity tube at particular points for the tracing of velocity patterns.

The control panel for automatically recording and timing the velocity readings of the midget current meter is shown in Fig. 3. This panel eliminates the usual concentration on the meter clicks and stop-watch trigger, which can become very monotonous after many hours of observation. The observer is relieved of constant attention to the current meter by a recorder, which is operated by the meter through a relay, as the meter commutator can only handle a very small current. A time switch opens the meter circuit after a selected time interval of between 30 sec and 2 min. The revolutions the meter has made during the time interval can be read from the counter, and repeat readings can be made by throwing a switch. The control panel is fitted with a signal lamp to indicate the end of the time interval. Clamps allow the panel to be attached to any part of the observation bridge. Standard attachment fittings are used for quick connections to the power-supply and current-meter circuits.

It is essential in movable-bed models that a constant and controlled source of sand be fed into the model at the intake end to simulate silt movement and deposition. It is desirable that the sand be well distributed as it falls into the water, and that the feeder device should operate with a minimum of attention. Figure 4 shows a satisfactory feeder designed by the writer, which meets these requirements. It consists of a conical hopper having an auger in the center, which is driven through

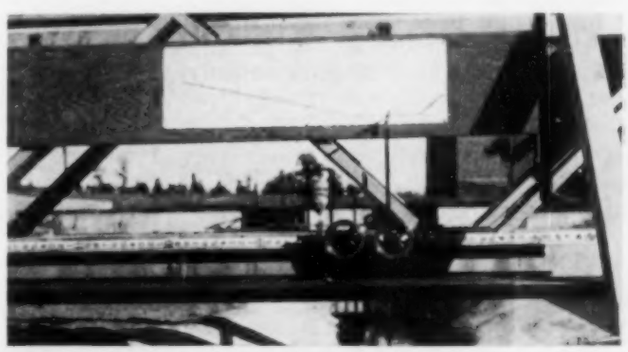


FIG. 2. THE PROFILOGRAPH, WHICH TRACES TO FULL SCALE THE PROFILE OF THE MOVABLE BED

reduction gears in such a manner as to force sand at a constant flow into a short length of pipe at the bottom of the hopper. The sand flow is throttled at the end of the pipe by a tapered plug. The clearance between the plug and the pipe-end is adjustable to obtain this throttling effect. The sand falls from the pipe-end onto a high-speed revolving fan-blade rotor which distributes it over the full width of the feeder base. A 5-in. impulse turbine provides a variable-speed drive for the auger and distributing rotor.

The laboratory water supply is furnished by a 14 by 12-in. low-head pump, coupled to a 40-hp motor. Normal operation of this unit makes available 9 cu ft per sec, which is discharged into the headworks forebay. A cross-connection to a 150-hp motor provides a flow of 15 cu ft per sec for unusual requirements. This pump supply may be supplemented by the drawdown from a 4 acre-ft storage pond, from which water is supplied to the headworks forebay through a 12-in. main. The total supply available with this drawdown amounts to 35 cu ft per sec. The headworks is so arranged that the flow may be diverted into any one of three different flumes which will carry the water to the experiments. Venturi meters are installed in the pipe line and the low-head discharge line as permanent measuring devices.

FIG. 3. CONTROL PANEL FOR AUTOMATIC TUNING AND RECORDING OF METER READINGS
Midget Current Meter at Left

FIG. 4. SAND FEEDER, LOCATED AT INTAKE END OF MODEL

This laboratory has been made possible by the WPA Construction and Professional divisions; it is operated as a Flood Control Research Project with a state grant from the state of Washington, Department of Conservation and Development. All work is under the direction of the writer. The University of Washington is acting as sponsor. A total of $27,000 of public funds has been expended on the laboratory facilities.

The writer designed and developed the equipment described herein, under the supervision of Prof. Charles W. Harris, with Profs. Robert B. Van Horn and Richard G. Tyler advising. All are members of the Society. Acknowledgment is also made of the many helpful suggestions received from John C. Stevens, M. Am. Soc. C.E., of Portland, Ore. To Professor Harris goes the credit for laying out and starting construction of the laboratory. The Portland and Seattle offices of the U. S. Corps of Engineers suggested the projects that are now being studied, and furnished the basic data.

Transforming from Plane to Geodetic Coordinates

By A. C. KALBFLEISCH
U. S. GEOLOGICAL SURVEY, WASHINGTON, D.C.

TRANSFORMATION from plane to geodetic coordinates on the Lambert projection can be accomplished more quickly and simply with natural functions than with logarithms, if a calculating machine is available. The accuracy of the solution depends only upon the precision of the natural function tables available and of the "zone tables" for the various states. The formulas required are based upon those developed in U. S. Coast and Geodetic Survey Special Publications 53 and 193, and the initial data are identical.

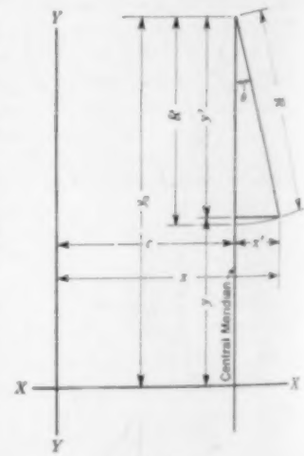


FIG. 1

Let x and y represent the plane coordinates of the station whose geodetic coordinates are required. The positions of the X and Y axes are arbitrary, except that the Y axis is parallel to the central meridian of the state or zone and the X axis is perpendicular to it with east as the positive direction.

The first step in the computation is to eliminate the arbitrary constants originally introduced in the determination of the plane coordinates to avoid negative values. For all states except Massachusetts and Connecticut, the constant C is 2,000,000 ft; for these states, C is 600,000 ft. The constant y_0 is determined for each zone as the value of R at the latitude where y equals zero.

From Fig. 1, $R = \sqrt{(x')^2 + (y')^2}$, where $x' = x - c$, $y' = y_0 - y$. Also, $\sin \theta = x'/R$. If R and θ are known, the geodetic coordinates can be determined by interpolation in the proper tables.

As an example, the geodetic coordinates will be computed for Wedell, S.C. (North Zone). For this zone, $y_0 = 31{,}127{,}724.75$. The rectangular coordinates for Wedell are $x = 2{,}027{,}010.22$, and $y = 399{,}420.85$. Applying the formulas,

$$x' = x - c = 27{,}010.22,$$
$$y' = y_0 - y = 30{,}728{,}303.90,$$

and $R = 30{,}728{,}315.77$.

A 10-bank calculating machine is essential for the computation. The value of y' is squared in the machine, and the result left on the dial. The keyboard is then cleared and the value of x' is squared, with proper regard for the decimal point. The final reading on the dial will be the sum of the squares, or R^2. The square root of this number can also be determined on the machine.

From Table I, North Zone, for South Carolina, prepared by the U. S. Coast and Geodetic Survey (Special Publication 193), we find by interpolation that this value of R corresponds to the latitude 34° 05′ 51.253″.

To determine the longitude, the value of θ must first be found:

$$\sin \theta = x'/R = 0.00879\ 00099$$

and, from a table of natural trigonometric functions, $\theta = 0°\ 03'\ 01.3070''$. By interpolation from Table II, North Zone, for South Carolina, the longitude of Wedell is found to be 80° 54′ 38.817″.

Care must be exercised in the computation to use the proper algebraic sign for $x - c$, since the sign indicates the location of the station with respect to the central meridian. The computation should be checked by the method outlined by J. L. Speert, Jun. Am. Soc. C.E., in a 1937 publication of the U. S. Geological Survey entitled "Formulas and Tables for the Transformation of Geodetic to Plane Coordinates on the Lambert and Transverse Mercator Projections."

Calculation of Square Root by Successive Approximations

By GEORGE H. DELL, ASSOC. M. AM. SOC. C.E.
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BY means of successive approximations, the square root of a given number can be easily and quickly computed to five significant figures on the slide-rule and, on computing machines, to approximately the full capacity of the machine.

Let x^2 be the given number, and let a^2 be a perfect square in the neighborhood of x^2; also let $|x^2 - a^2| = z$. The value of x is then given by the identity,

$$x \equiv a \pm \frac{z}{a + x} \quad \ldots\ldots\ldots\ldots [1]$$

the positive sign being used when $a^2 < x^2$ (first case), and the negative sign, when $a^2 > x^2$ (second case).

For calculating the value of x in the first case, Eq. 1 is rewritten as follows:

$$x = a + \frac{z}{2a + (x - a)} \quad \ldots\ldots\ldots\ldots [2]$$

while, in the second case, the desired relation is given by

$$x = a - \frac{z}{2a - (a - x)} \quad \ldots\ldots\ldots\ldots [3]$$

In finding square roots by this method, a first approximation, x_1, is found by omitting from the denominator the term in parentheses, hence Eqs. 2 and 3 become, respectively,

$$x_1 = a + \frac{z}{2a} \quad \ldots\ldots\ldots\ldots [2a]$$

and

$$x_1 = a - \frac{z}{2a} \quad \ldots\ldots\ldots\ldots [3a]$$

The resulting values of x_1 are generally correct to four significant figures and hence give sufficient precision for ordinary engineering computations.

If additional approximations are required, they are found by including in the denominator the previously determined value of the fractional term. Thus, the second approximation is given by

$$x_2 = a + \frac{z}{2a + \frac{z}{2a}} \quad \ldots\ldots\ldots\ldots [2b]$$

or

$$x_2 = a - \frac{z}{2a - \frac{z}{2a}} \quad \ldots\ldots\ldots\ldots [3b]$$

Likewise, the third approximation is given by:

$$x_3 = a + \frac{z}{2a + \frac{z}{2a + \frac{z}{2a}}} \quad \ldots\ldots\ldots\ldots [2c]$$

or

$$x_3 = a - \frac{z}{2a - \frac{z}{2a - \frac{z}{2a}}} \quad \ldots\ldots\ldots\ldots [3c]$$

Example 1. Find $\sqrt{205}$ to five significant figures, using the slide-rule. Solution: Since 196 (= 14 × 14) is a perfect square in the neighborhood of 205, the value of a in Eq. 2 will be taken as 14, whence $z = 205 - 196 = 9$. By Eq. 2*a*, $x_1 = 14 + \frac{9}{28} = 14 + 0.322$. By Eq. 2*b*, the second approximation is given by $x_2 = 14 + \frac{9}{28.322} = 14 + 0.318$. The third approximation, if required, would be $x_3 = 14 + \frac{9}{28.318}$; however, it is seen that the slide-rule setting for the third approximation would not be distinguishably different than that used in the second approximation, and hence, from a practical standpoint, the convergence is completed with the second approximation, the required value of $\sqrt{205}$ to five significant figures being 14.318.

Example 2. Find $\sqrt{1{,}500}$, using a computing machine. Solution: Since 1,521 (= 39 × 39) is a perfect square in the neighborhood of 1,500, the value of a in Eq. 3 will be taken as 39, whence $z = 1{,}521 - 1{,}500 = 21$. From Eq. 3*a*, $x_1 = 39 - \frac{21}{78} = 39 - 0.2692$, and from Eq. 3*b*, $x_2 = 39 - \frac{21}{78 - 0.2692} = 39 - 0.270163$.

Before computing the third approximation, the error in the second approximation may be estimated from a consideration of the error in the denominator of the fractional term. In this way, the error is found to be approximately $\frac{0.2702 - 0.2692}{77.73} \times 0.27 = 0.000003$.

The third approximation, if required, is obtained from Eq. 3*c* as follows:

$$x_3 = 39 - \frac{21}{78 - 0.27016} = 39 - 0.2701666,$$

at which stage the capacity of the computing machine was exhausted. The value of $\sqrt{1{,}500}$ to nine significant figures is therefore 38.7298334.

New Universal Straining Frame Aids Photoelastic Research

By H. E. WESSMAN, M. AM. SOC. C.E.
COLLEGE OF ENGINEERING, NEW YORK UNIVERSITY, NEW YORK, N.Y.

A PHOTOELASTIC and model-analysis laboratory has recently been established at New York University and will be used by graduate students and staff members in connection with regular course work and research investigations. The photoelastic equipment employs polaroid lenses as the principal optical units. Both monochromatic and white-light sources are available, so that photographs of fringe patterns may be obtained, or colored images projected on a screen for demonstration purposes. An electrical annealing oven will be used to produce stress-free models.

The new universal straining frame will be of particular interest to institutions desiring a simple, low-cost unit. Designed and built at the university, it can be duplicated for less than $150. Briefly, it consists of a frame within a frame, mounted on a base plate, so that both vertical and horizontal movement of the specimen is possible. The accompanying picture clearly shows the screws for controlling the motion. The loading is applied through a weighted lever arm with a multiplying ratio of four to one. The loading arm may be shifted vertically to any position dictated by the type of specimen by inserting the fulcrum pin in the hole at the proper level. The arm is made of 17S-T aluminum alloy in order to reduce the size of the counterweight. The sliding frame on which the specimens are mounted is made with double bars, and permits of many different types of loading.

MANY TYPES OF PHOTOELASTIC MODELS CAN BE TESTED IN THIS FRAME (SEE FIG. 1 FOR STRUCTURAL DETAILS)

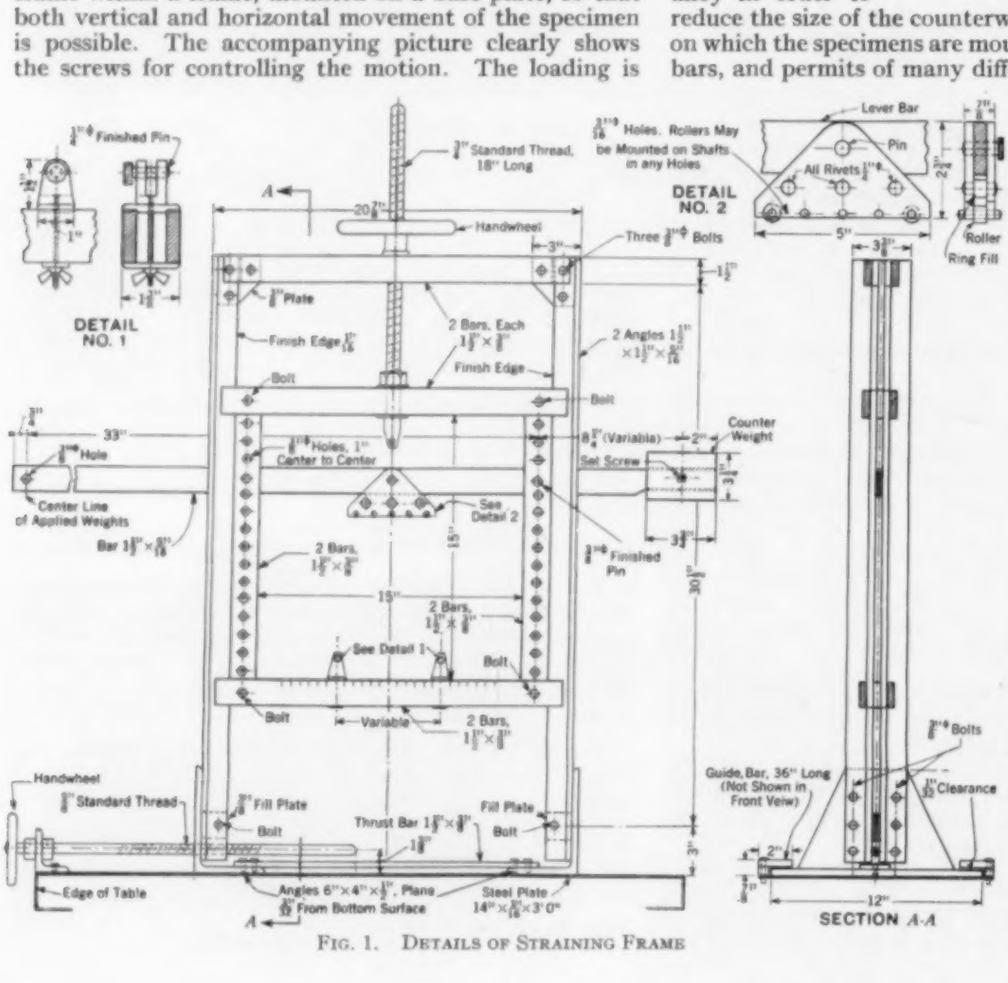


FIG. 1. DETAILS OF STRAINING FRAME

Details of the frame and some of the accessories are shown in Fig. 1. Various small holders and supports may be built to facilitate the testing of simple beams, cantilever beams, rigid frames, arches, tension specimens, compression specimens, foundation specimens on gelatin beds, and many other machine and structural models.

In the photograph a model of a two-hinged rigid bent is shown under test. Loading contact is made by means of a clevis unit suspended freely from the loading arm. Small rollers are inserted in this unit and bear against the specimen. The position of the rollers may be changed to give a variety of load points, such as a center concentrated load or a series of loads symmetrical with respect to the center line.

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Denver Makes City Survey a Relief Project

To the Editor: The report of the American Engineering Council, published in the June issue of Civil Engineering, emphasizes the fact that projects are most needed in urban areas if the unemployed are to be most effectively used on the forthcoming work relief projects. It described numerous projects of a work relief nature, whose possibilities have been so thoroughly exploited in recent years that they do not deserve much attention in the new plan of activities. It continued with many thoughtful suggestions to engineers who are in a position to influence the selection of public works and work relief projects.

However, one very useful type of project—the city survey—was overlooked. Such a project was financed by the Works Progress Administration and sponsored by the City Department of Improvements and Parks of Denver, Colo.

Over a period of 18 months, 300 relief workers were trained and 96 maps were completed, under the technical direction of the U. S. Geological Survey. One small group of WPA workers took the aerial pictures, developed the films, made the contact prints, took the ratio-check measurements, computed the tilts of the pictures and the angles of rectification, and made the enlarged ratio prints on an approximate ground scale of 200 ft to the inch. Another group of 88 investigated the existing control and established 62 miles of second-order and 245 miles of third-order levels, and tied in more than 3,000 city benchmarks established on other than the national datum. They established 19 second-order triangulation stations, and 245 miles of second-order transit traverses were run. All existing permanent marks were tied in; 88 new permanent marks and 3,291 intermediate points within the city were established and their x and y values determined on the Colorado State Coordinate System. The topography was sketched on photographic bases, and a maximum of 110 workers was required to map the 60 sq miles on the scale of 200 ft to the inch with a contour interval of 2 ft. An office force, averaging 41 persons, laid out the projections, plotted the control points, built up additional control with radial line intersections, compiled and inked the culture and the topography, and lettered the 96 (20 × 25-in.) maps. The work of inspection and editing employed 17, and another 26 were assigned to administration.

The completed project proved so satisfactory to the agencies involved that similar arrangements were made for mapping 800 sq miles of the metropolitan area surrounding Denver on a $^1/_{24,000}$ scale and a 10-ft contour interval.

Max. J. Gleissner, M. Am. Soc. C.E.
Division Engineer, in charge of Planimetry and Editing, U. S. G. S. Denver Survey

Denver, Colo.

Old Section Corners in Florida Should Be Reestablished

Dear Sir: Mr. Gillespie's splendid paper in the May issue presents an excellent picture of the land survey situation in Florida and of the surveyor's problems as he retraces the old land lines. Many of these problems are common to other states as well. When the average engineer first leaves college he has rather a contempt for land surveying, but the more he does of it the more respect he has for this branch of professional work. Here both science and art enter, as has been remarked in other discussions.

One element that has entered into the Florida land survey problem, which is intended to simplify the settlement of disputes but which many times complicates matters for the conscientious surveyor, is a ruling attempting to legalize as a section corner a post that has been generally accepted by surveyors for a number of years. This ruling is obviously invalidated by the congressional legislation requiring that lost or obliterated corners of the approved surveys be restored to their original locations whenever possible.

As Mr. Gillespie states, one is frequently surprised at the amount of evidence a careful examination of the subsoil will disclose to the experienced eye, but I would like to emphasize that this evidence is rapidly disappearing. Wooden markers and the stumps and roots of witness trees are nearly gone, and each excavation at the site of a section corner tends further to destroy this evidence. If permanent monuments are not put in position when the corner's position is relocated, the work of the next surveyor is made much harder. It is high time that an authoritative resurvey is made and the old corners reestablished. In the judgment of many, this should be carried along with geodetic control so that when one of these points is again lost, it can be quickly reestablished by accurate methods.

I favor the use of the system of plane coordinates based on the plane rectangular coordinates of the triangulation and traverse stations of the U. S. Coast and Geodetic Survey. Most of us seem to be thinking along the same lines.

Just now would be a most opportune time to get this important work done. Both skilled and unskilled labor would be needed, and this would therefore be a good relief project. The technical work should properly be the responsibility of the state and local government agencies, but carried on under the direction of the U. S. Land Office. Where the Coast and Geodetic Survey have not completed their triangulation system, that should be done.

We have a precedent for this in the Florida Mapping Project and in Louisiana, where in a number of parishes the Coast and Geodetic Office has supervision over field parties furnished by the WPA monumenting between triangulation stations established by the Coast and Geodetic Survey. This was begun by the CWA in 1933 and continued by the ERA of Louisiana, the FERA, and finally the WPA.

The legal profession, I believe, can be counted upon for help and cooperation in getting such a project through, if the matter is properly presented to them. Their interest was shown in the appointment by the American Bar Association of a committee to work with the Society in the matter of legal descriptions.

Winston E. Wheat, Assoc. M. Am. Soc. C.E.
County Engineer, Escambia County

Pensacola, Fla.

Comments on Strain Measurements

Dear Sir: In connection with the article, "The Equiangular Strain-Rosette," by Raymond D. Mindlin, Jun. Am. Soc. C.E., in the August issue, it may be apropos to point out that the use of 60-deg angles for the strain-gage measurements imposes a needless and not always practical restriction for this type of measurement.

It is usually more satisfactory to use 45-deg gage angles for the determination of the principal strains. In this manner four strain readings may be taken at a point, the extra reading acting as a check and also giving an indication of the limits of accuracy of the measurements. This procedure is especially applicable when one uses the graphical method of "Land's Circle" or the "dyadic circle" for the determination of the principal stresses. A thorough description of the practical application of the graphical method of the "dyadic circle," as applied in various tests, appears in a paper by Messrs. Osgood and Sturm entitled "The Determination of Stresses from Strains on Three Intersecting Gage Lines and Its Application to Actual Tests" (Bureau of Standards, Journal of Research, Vol. 10, January–June 1933). As stated by the authors, who used 45-deg rosette readings in their tests, "The use of four gage lines shows the limits of accuracy of measurement by the differences in the radii of the four dyadic circles from the various combinations of

strains on any three of the four lines." The value of the fourth reading as a check measurement can well be appreciated when a great number of readings are taken and these are liable to the usual sources of personal and instrumental error. When 45-deg gage lines are used the graphical solution becomes greatly simplified.

For cases where strain measurements are obtained by means of optical extensometer principles, as in the method used for the determination of surface strains in concrete slabs, the angles at which the extensometers are set will depend on the available laboratory space and will be governed by the line of sight of the telescopic instruments. A prescribed angle restriction might impose unnecessary difficulties for such strain measurements.

By the substitution of 45-deg angles for the 60-deg angles used by Mr. Mindlin, his basic Eq. 2 becomes further simplified. Thus substituting $\theta_a = 0$, $\theta_b = 45°$, $\theta_c = 90°$ in the three expressions,

$$\epsilon_a = \epsilon_x \cos^2 \theta_a + \epsilon_y \sin^2 \theta_a + \epsilon_{xy} \sin \theta_a \cos \theta_a$$
$$\epsilon_b = \epsilon_x \cos^2 \theta_b + \epsilon_y \sin^2 \theta_b + \epsilon_{xy} \sin \theta_b \cos \theta_b$$
$$\epsilon_c = \epsilon_x \cos^2 \theta_c + \epsilon_y \sin^2 \theta_c + \epsilon_{xy} \sin \theta_c \cos \theta_c$$

there results:

$$\epsilon_x = \epsilon_a$$
$$\epsilon_y = \epsilon_c$$
$$\epsilon_{xy} = 2\epsilon_b - \epsilon_a - \epsilon_c$$

Also, the principal strains of Eq. 4 become

$$\epsilon_1 = \tfrac{1}{2}(\epsilon_a + \epsilon_c) + \tfrac{1}{2}\sqrt{(\epsilon_a - \epsilon_c)^2 + (2\epsilon_b - \epsilon_a - \epsilon_c)^2}$$
$$\epsilon_2 = \tfrac{1}{2}(\epsilon_a + \epsilon_c) - \tfrac{1}{2}\sqrt{(\epsilon_a - \epsilon_c)^2 + (2\epsilon_b - \epsilon_a - \epsilon_c)^2}$$

and $$\tan 2\phi = \frac{2\epsilon_b - \epsilon_a - \epsilon_c}{\epsilon_a - \epsilon_c}$$

New York, N.Y. WALTER GRAY, Jun. Am. Soc. C.E.

[*Editor's Note:* A typographical error appeared in the original article by Mr. Mindlin. In Eq. 2, line 1, θ_{xy} should read ϵ_{xy}.]

A Young Engineer Looks at the Code of Ethics

TO THE EDITOR: From time immemorial man has instituted codes to govern his actions. The Society has a code of ethics—and there is no quarrel over the need of such a code.

The present code contains standards governing the technical relationships of the members with each other and with their clients or employers. But is this enough? Should not any code contain standards of character that will govern man's relationships in every phase of life? The engineer who cannot be respected for his actions outside the technical phases of his life reflects on the reputation of the entire profession. An engineer is first a man—then an engineer. And the kind of man he is has much to do with the kind of engineer he can be. The old axiom, "The whole is equal to the sum of all its parts and is greater than any of them," is true whether it is applied geometrically or to human life.

At present there is much discussion on the subject of improving the status of the engineer, both economically and with respect to the proper recognition of his true value by the general public. In what better way can the engineering profession obtain its rightful recognition from the general public than by comprising a membership of such high character that it stands out from the rank and file of society?

The engineer's code of ethics should also warn of the dangers of being too self-centered and should stress the engineer's social obligations. By social obligations I mean a keen interest in, and a working knowledge of, governmental affairs as well as respect for the rights of others and attention to other civic responsibilities. Too long has the engineer taken a back seat and let others who do not have his keen, practical, and analytical insight control the reins of government. Indeed, it is the sacred duty of every citizen to take an active and intelligent interest in the affairs of his government. Can the engineer ever expect to have adequate licensing laws unless he takes an active part in governmental affairs? Would there not be more efficiency in public works if the engineer were more interested in matters of government? The duty of the engineer to the public is paramount, and his code should definitely point out his social obligations. Only when the engineer takes a more active interest in governmental affairs can he expect an increase in his public prestige—provided all of his actions are motivated by an honest desire to serve faithfully.

Thus the engineer needs a code that specifically states (1) the importance of fine personal character in all walks of life and (2) his responsibility to society. The inclusion of these statements in the engineer's code will constantly remind him of his goal.

A code of ethics can do much to instill the right ideals in the mind of the engineer—especially the young engineer. The young engineer in his trying years of training in subprofessional work can easily lose his way unless he has the right ideals, keeps a steady head, continually strives for high ethical standards, and takes an intelligent interest in public affairs. In this way he will learn always to act in a way that will bring honor and distinction to both himself and the profession.

JOHN M. HAYES, Jun. Am. Soc. C.E.
Engineering Draftsman,
Tennessee Valley Authority
Chattanooga, Tenn.

The Library Habit

TO THE EDITOR: The article by Dr. Craver, in the July issue, on "The Role of the Library in Engineering Education and Research" is so comprehensive that it can be read with profit by every engineer who has access to a library.

Every prospective engineer should form what may be called "the library habit." He should do so in his college days. I will quote the introductory paragraph of an article that Prof. C. H. Benjamin wrote thirty years ago ("The Library Habit," *The Purdue Engineering Review*, No. 4, 1908): "By the library habit, I mean the custom of going to the library when in need; of learning whereabout on its shelves are the books and papers which will help one in his particular field of study or special line of research; of going there whenever one has a leisure hour and skimming the latest periodical, jotting down now and then notes on whatever interests him, perhaps indexing the articles which will probably be of use in the future. Once become a habit, it will become one of the pleasures of life and not readily foregone."

Our printed engineering resources are enormous. Prof. H. Martin Telleen made it the subject of a paper, "Printed Engineering Resources," which appeared in *Engineering Education* for November 1914. In this paper he stated that his purpose was "to sketch broadly some of the important accumulations of engineering books, pamphlets, periodicals, and other printed matter." Since that time, twenty-four years ago, these accumulations have increased by leaps and bounds, especially in the case of periodicals. Dr. Craver emphasizes the fact that periodicals are of primary importance. The engineer with the library habit will not pass them by unnoticed. For many years the writer has averaged one or two hours each week browsing among the technical periodicals in one or another of the larger libraries in New York City. A note is made of any article or statement that strikes him as likely to be wanted at some future time.

The photostat is an invaluable aid in extending the services of a great library to those deprived of its privileges. The engineer in lone places, apart from his fellows, may at small cost procure copies of papers, articles, tables, drawings, extracts from books, and the like which would otherwise be difficult to obtain.

A companion of the library habit should be the notebook habit. An extract from an article on this subject by the writer may not be out of place: "Let it here be said to all keepers of notebooks that references or extracts liable to be wanted should be made on the spot. Many a weary hour has been spent in looking up material when this was neglected. The title, author, volume and page number with date of publication, all given correctly, will in many cases be all the reference necessary if wanted for quotation later. Little is gained by making a synopsis. Certain paragraphs may be wanted in full. If so, care should be taken in copying them. They can then at any time be quoted as the language of the book without further reference. This is especially important with notes from books or papers not easy of access." (*Engineering and Contracting*, Vol. LXVII, p. 285, June 1928.)

ROBINS FLEMING
New York, N.Y.

Stresses in Continuous Beams by Moment Distribution Method

DEAR SIR: Equations 15 and 16, presented by Odd Albert in his article in the June issue, give correct results for the simple example proposed, in which the spans are all equal and the moment of inertia is the same in all three spans. However, this ideal case is very seldom encountered in actual practice. Also, the structure may consist of more than three spans, and the ends may be restrained—in which case the equations given are not sufficient.

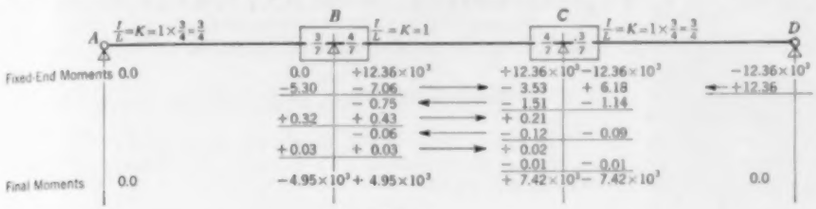


FIG. 1.

The solution by the moment distribution method of the example given by Professor Albert for three equal spans is shown in Fig. 1. Anyone familiar with this method can solve the moments at the supports due to deflection for any number of spans, with prismatic beams and of different moment of inertia, in a very short time.

From the general slope deflection equation, the fixed-end moment of a prismatic beam when one end is deflected d in. from the other end is $\frac{6EdI}{L^2}$. Using the convention of a plus sign for any moment tending to rotate a joint clockwise, and a minus sign for moments in the opposite direction, the fixed-end moments of beam BC with a $^3/_8$-in. deflection of support C are $+12.36(10)^3$ ft-lb, and the fixed-end moments in beam CD are $-12.36(10)^3$ ft-lb. As the moment of inertia is constant for all spans, and as the spans are all equal, the relative stiffness, I/L, of each beam of the three spans can be called unity. If the spans were not equal and the moments of inertia of the prismatic beams were not constant, then the actual I/L values would have to be used for each span. Since the end spans are simply supported or hinged, spans AB and CD are only three-fourths as stiff as if the spans were restrained at the ends A and D. As the supports A and B of span AB do not deflect, the fixed-end moments are zero.

Considering the relative stiffness of beam BC as unity, and as beams AB and CD are hinged at A and D, respectively, then the relative stiffness of beams AB and CD is $^3/_4$. This means that, if moments are balanced around joint B, $^4/_7$ of the unbalanced moment goes to beam BC, and $^3/_7$ to BA. As shown in Fig. 1, the final moment at support B is $4.95(10)^3$ ft-lb, and the moment at support C is $7.42(10)^3$ ft-lb. These results check with those given by Professor Albert. Using a similar process, the moments at the various supports of any number of spans with prismatic beams, where the moment of inertia is different in the various spans, can be solved in a very short time.

A. W. FISCHER
Assistant Structural Engineer,
Construction Service,
Veterans Administration
Washington, D.C.

Water Problems in Florida

TO THE EDITOR: Florida is a large state, and although it presents no wide range in topography it does have marked differences in surface runoff. This fact has been very satisfactorily brought out by Mr. Wallace in his article in the June issue, and the reason for such differences has been correctly interpreted—namely, the character of the underlying geologic formations in the several sections of the state and the influence of each on surface runoff.

The importance and value of stream-flow measurements and surface runoff data have not been generally appreciated in Florida. With the greater expansion of industry there will be a greater demand for information of this kind, but to be of the fullest value such records should cover long periods of time. The lack of data such as Mr. Wallace presents has already had disastrous results on a number of construction projects in Florida, and the lack of accurate long-time records has often proved costly in planning structures. Such emergencies as arise when we deal with natural forces and agencies can be guarded against only by having records as a guide, and these records can be obtained only by painstaking methods covering years of "highs" and "lows" as well as the more or less normal periods.

Another fact that Mr. Wallace brings out is the close relationship in Florida between surface water and ground water. Study of the one must include consideration of the other, for in a number of areas they are inseparable, and if this fact is not appreciated it may be impossible to solve problems arising in surface-water studies. It is to be hoped that Mr. Wallace's paper, emphasizing as it does the value of the work already done in indicating the need for additional work in the state, will so stimulate interest in surface-water studies that the work can continue on a broader scale.

I also read with keen interest and much profit Mr. Pirnie's paper on "Treatment of Florida's Artesian and Surface Water Supplies," in the May issue. The subject of the treatment of water for industrial and municipal purposes is exceedingly important, and Mr. Pirnie's paper indicates that our municipalities are constantly increasing their efforts to improve the quality of their water supply. Obviously, also, certain industries cannot locate within an area unless suitable supplies are obtained.

I note that Mr. Pirnie gives a timely warning of the dangers of overdraft and the results that may be expected. It is certain that some sections of Florida will be called upon to guard against this danger most closely. An unprecedented increase in draft may result in a situation that cannot be easily remedied. It is a good idea to watch closely any fluctuations in water level resulting from too great a demand. Otherwise, as Mr. Pirnie points out, there may be disastrous results.

HERMAN GUNTER
State Geologist
Tallahassee, Fla.

Free-End Column with Eccentric Load

DEAR SIR: In an article on "Deflection of Free-End Column or Hanger with Eccentric Load," in the May issue, Mr. St. John derived the expression $\Delta = \frac{6Pbl^2}{12EI - 5Pl^2}$ by assuming the elastic curve as a parabola.

The following (exact) expressions to the second power were derived by solving the differential equations and expanding the trigonometric functions by using Maclaurin's power series of x.

Referring to Mr. St. John's Fig. 1(a), $M = Pb + P\Delta - Py$, or

$$\frac{d^2y}{dx^2} + \frac{P}{EI}y = \frac{P}{EI}(b + \Delta). \quad \text{Let } a^2 = \frac{P}{EI}$$

Solving, $Y = C_1 \cos ax + C_2 \sin ax + b + \Delta$.

Values of C_1 and C_2 are found from end conditions, and by expanding sin and cos to the second power we obtain $\Delta = \frac{Pbl^2}{2EI - Pl^2}$. This corresponds to Mr. St. John's Eq. 3.

For the deflection of the hanger (Mr. St. John's Fig. 1b), $M = Pb - P\Delta + Py$ or

$$\frac{d^2y}{dx^2} - \frac{P}{EI}y = \frac{P}{EI}(b - \Delta). \quad \text{Let } a^2 = \frac{P}{EI}$$

Solving, $y = c_1e^{ax} + c_2e^{-ax} - (b - \Delta)$. As before, values of C_1 and C_2 are found from end conditions, and by expanding e^{ax} and e^{-ax} to the second power we obtain $\Delta = \frac{Pbl^2}{4EI + Pl^2}$. This corresponds to Mr. St. John's Eq. 4.

SCOTT W. ORR, Assoc. M. Am. Soc. C.E.
Needham, Mass.

SOCIETY AFFAIRS

Official and Semi-Official

Fall Meeting at Rochester, N.Y., to Offer Varied Attractions

Six Technical Divisions Schedule Timely Papers; Interesting Social Events and Inspection Trips

PLANS FOR the Fall Meeting of the Society, which opens at Rochester, N.Y., on October 12, were given brief mention in the August number of CIVIL ENGINEERING. Program arrangements are now nearing completion, so that it becomes possible to announce the subject matter of the entire meeting, as well as the plans for the social events, ladies' entertainment, and inspection trips.

On Wednesday, October 12, there will be sessions morning and afternoon, with a dinner and dance in the evening. On Thursday and Friday, technical sessions will be held in the forenoons, with excursions and inspections in the afternoons. The following is a summary of the technical features:

WEDNESDAY, October 12, 1938—Morning

After the customary addresses of welcome and response by the President of the Society, the Structural Division has arranged for a paper on

"Advances in Structural Analysis Over Three Centuries—In Commemoration of the 300th Anniversary of the Beginning of Modern Structural Theory"

WEDNESDAY, October 12, 1938—Afternoon

STRUCTURAL DIVISION

"History of the Thousand Islands Bridge Project"
"Design and Construction Features of the Thousands Islands Bridge Project"
"Structural Features of the New York Central Grade Separation Project in Syracuse"

WATERWAYS DIVISION

Flood Control Studies and Works for New York State Rivers

"Hydraulic Model Tests for the Southern New York Flood Control Project"
"Genesee River Flood Control and Related Problems"
"Results of the Operation of the Sacandaga Reservoir in Regulating the Hudson River"

THURSDAY, October 13, 1938—Morning

POWER DIVISION

Symposium on Power Plant Design and Efficiency

"Trend in Power House Space Limits and Equipment Costs in Relation to Head, Size of Units, and Total Kilowatt Installation"
"Turbines, Power House Models, and Prototype Tests"
"Initial Investigations and Economical Planning of Hydroelectric Plants"

SOIL MECHANICS AND FOUNDATIONS DIVISION

Opening Address
"The Practical Application of Soil Mechanics in Substructure Problems"
"Settlement Studies of Structures"

SANITARY ENGINEERING DIVISION

"Progress in the Control of Water Pollution in New York State"
"New Intercepting Sewer and Disposal Plant at Syracuse, N.Y."
"Buffalo's New Sewage Disposal Plant"

FRIDAY, October 14, 1938—Morning

POWER DIVISION

Continuation of Symposium on Power Plant Design and Efficiency

Progress and Economical Principle of Design of Turbines, Intakes, Penstocks, Valves, Scroll Cases, Elbows and Draft Tubes
"Preliminary Selection of Hydraulic Turbines and Power House Dimensions"

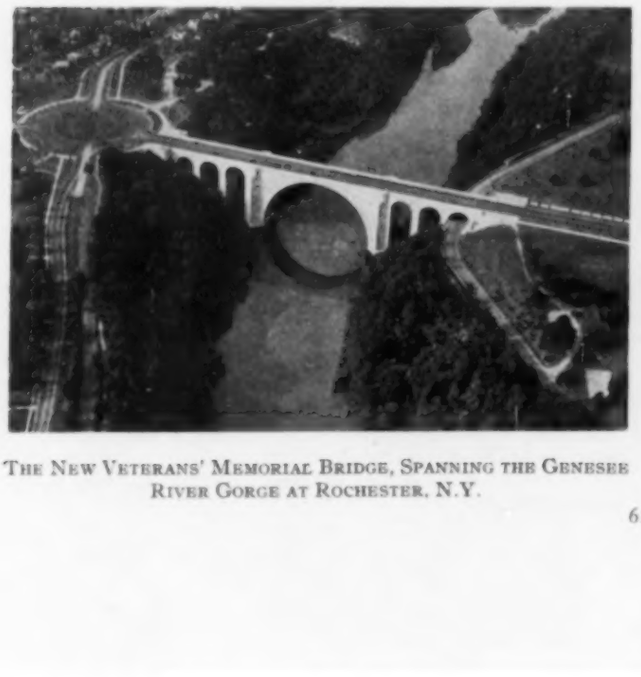
SOIL MECHANICS AND FOUNDATIONS DIVISION

"Soil Studies at the Muskingum Conservancy District, Theory and Observation"
"Application of Soil Mechanics and Foundation Engineering on the Fort Peck Dam"

CITY PLANNING DIVISION

Symposium on Urban Traffic Control

Introductory Paper—Engineering Aspects
"Traffic Control Problem as Related to Buffalo"
"Traffic Control Problem as It Relates to Rochester and Vicinity"



THE NEW VETERANS' MEMORIAL BRIDGE, SPANNING THE GENESEE RIVER GORGE AT ROCHESTER, N.Y.

FOR INFORMAL CONFERENCES, THE GOLF COURSE AT GENESEE VALLEY PARK, ROCHESTER, OFFERS INTERESTING POSSIBILITIES

SOCIAL FEATURES

Interspersed with the technical sessions will be a number of social events for members and their ladies, and special entertainments for the ladies. A summary of the social features already in preparation follows:

WEDNESDAY, October 12, 1938—Morning and Afternoon

Ladies' Get-Acquainted Luncheon followed by motor tour of Rochester residential district, parks, and lake shore
Visit to Memorial Art Gallery

Evening

Dinner and Dance at Hotel Seneca

THURSDAY, October 13, 1938

Motor Trip for Ladies to Niagara Falls and Old Fort Niagara, with Luncheon at Fort Niagara Officers' Club

Evening

Musical Program for Members, Ladies, and Guests at Eastman Theater, Followed by an Address on Color Photography

FRIDAY, October 14, 1938

Ladies' Luncheon, Followed by Tour of Kodak Park of the Eastman Kodak Company

On account of the variety of industries situated in Rochester that are not found in other cities, the Fall Meeting will offer a number of inspection trips of unusual interest. To date, the following excursions have been planned:

EXCURSIONS

THURSDAY, October 13, 1938—Afternoon

Trip Through Plant of Eastman Kodak Company, with Luncheon in Company Restaurant

FRIDAY, October 14, 1938—Afternoon

Trip to Plant of Bausch and Lomb Optical Company and Taylor Instrument Company
Arrangements will also be made for sanitary engineers to visit projects of interest in the vicinity.

These excursions are worthy of mention in some detail. The Eastman works are virtually a city within a city, comprising 90 buildings in the 400-acre Kodak Park. More than 3,500 different products—including film, paper, plates, and chemicals—are produced there. The visitors will have an opportunity to inspect modern laboratories for production testing, the largest interconnected refrigeration plant in the world, the machine shop and heat-treating department, and many other interesting features in addition to the manufacturing departments themselves.

At Bausch and Lomb, there will be an opportunity to see the assembly and inspection of microscopes, refractometers, photomicrographic and X-ray apparatus, and many other special optical instruments. The visitors will also be taken through the shops to see the numerous operations performed by automatic machines, turret lathes, and diamond turning processes; the manufacture of lenses; and the making and assembling of eyeglass frames.

MEMORIAL ART GALLERY, WHERE THE LADIES WILL BE ENTERTAINED ON THE OPENING DAY OF THE FALL MEETING

At the Taylor Instrument Company some 8,000 different instruments for measuring or controlling temperature, pressure, and other elements are manufactured. The production of precision glass thermometers for laboratory use, and the elaborate equipment for tooling and gaging should attract special attention on this trip. Another highlight will be a visit to the demonstration room, where instruments in operation display the latest refinements in design and operating principles.

For the Fall Meeting, the program as a whole is being arranged under the direction of Carey H. Brown, chairman of the Local Committee. The ladies' entertainment is being arranged by a committee headed by Mrs. Carey H. Brown, and the technical program has been arranged under the direction of Carl C. Cooman, chairman of the Technical Program Committee. Complete details on the entire program and the personnel of the local committees will be carried in the October issue of CIVIL ENGINEERING.

Amendment to By-Laws—"Article IV. Committees"

FOLLOWING notice given at the April meeting of the Board of Direction, in Jacksonville, and in accordance with constitutional requirements, action was taken on amending Article IV of the By-Laws, which relates to committees, this action being effected by the Board on July 18, 1938, at Salt Lake City, Utah. In effect the amendment abolishes the Committee on Professional Activities and provides that the technical department report to the Board through the Committee on Technical Procedure. Article IV will then read as follows:

"1. The Board of Direction shall meet within twenty days after the Annual Meeting of the Society, and shall then appoint from its own membership the following Standing Committees:

"An Executive Committee, as provided in the Constitution, Article VI, Section 3.

"A Committee on Honorary Membership.

"A Committee on Districts and Zones.

"A Committee on Professional Conduct.

"A Committee on Publications.

"A Committee on Membership Qualifications.

"The Board may appoint other Committees from time to time from its own membership or otherwise and such Committees shall be grouped into three Departments—Administrative, Professional, and Technical, the Technical Department reporting to the Board through the Committee on Technical Procedure."

Sections 2 to 7 remain as before.

Omit Section 8, as previously given, and renumber succeeding Sections to correspond. Section 8 will then be amended to read:

"8. *The Administrative Department* shall be composed of several units. In general each unit or committee will consist of one Board member appointed for one year and of four non-Board members appointed at the outset for terms of one, two, three, and four years, respectively, and thereafter for four-year terms. Each committee shall have a Chairman and a Vice-Chairman appointed by the Board. Each committee shall act as advisory to the Board, and as the administrative agent of the Board with respect to approved plans."

Section 9 (formerly Section 10) as revised will read as follows:

"9. *The Professional Department* shall be composed of several units. In general each unit or committee will consist of one Board member appointed for one year and of four non-Board members appointed at the outset for terms of one, two, three, and four years, respectively, and thereafter for four-year terms. Each Committee shall have a Chairman, and a Vice-Chairman appointed by the Board. Each committee shall act as advisory to the Board, and as the administrative agent of the Board with respect to approved plans."

Beginning with its second paragraph, the present Section 10 will remain as an integral part of the revised Section 9. Similarly, the present Sections 11 and 12 will remain except that they will be renumbered, respectively, as Sections 10 and 11.

Note: The adoption of this amendment opens the way to the adoption also of an anticipated amendment establishing the newly authorized Committee on Professional Objectives. EDITOR.

New Committee on Professional Objectives

As Covered by Report of Special Committee on Proposed Professional Division, to the Board of Direction at Its Salt Lake City Meeting

July 17, 1938

To the Board of Direction
Gentlemen:

The consideration of the formation of a Professional Activities Division of the Society was formally initiated when a petition was submitted to the Board at its January 1937 meeting, requesting the Board to create such a Division looking towards the Society concerning itself "with subjects incident to the professional practice of engineering, with the objectives of maintaining and developing high standards of practice and ethics, promoting understanding among engineers and between the profession and the public and increasing the usefulness of the profession to the Society."

Some of the more important and specific purposes of the proposed Division were stated to be:

1. To supplement and strengthen the work of the Board of Direction of the Society in "the professional improvement of its members," as stated in the constitution to be an "object" of the Society.

2. To amplify Local Section activity and to facilitate the working together of a large number of members who are interested in the affairs and development of both salaried and employer engineers.

3. To provide an agency through which our members may express themselves more freely and effectively on professional matters, as for example, through the organization of forums for the discussion of professional matters at the quarterly meetings of the Society.

4. To consider legislation affecting the status of the engineer and also those national and public developments and trends affecting the status of the engineer.

5. To consider the humanities of the engineering profession.

The Board of Direction referred this petition to the Committee on Aims and Activities with instructions that that committee thoroughly study the subject and report back to the Board. The Aims and Activities Committee met twice for the purpose of considering and discussing this matter and at the July 1937 meeting of the Board submitted its report. This report was quite exhaustive and showed a thorough study of the subject by the committee and closed with the definite recommendation that "The formation of a Professional Activities Division be approved." This report included the statement that all of the "objectives of the proposed Division, except the implied invitation to open discussion, have been recognized for many years." This report also included the statement, "It must be recognized that intelligent discontent is the driving force behind every useful advance in every line of endeavor and it may be that a Professional Activities Division, under strong leadership, can provide an outlet for constructive criticism which may serve a good purpose without jeopardizing the paramount technical objectives of the Society. There can be little doubt that if the proposal of a Professional Activities Division were put to a vote of the general membership, it would be approved by a large majority, the greater part of which vote would be based on a desire to improve economic conditions."

The Board at its July 1937 meeting appointed a committee of its own members to further survey the matter and to report its definite recommendations. The first action of this committee was to address a letter to the chairman of each of the committees of both the professional and administrative departments of the Society. This letter outlined the history and background of the movement, attached copies of the original petition, the report of the Aims and Activities Committee and related correspondence, and requested considered opinions as to the desirability and merits of the proposal and that particular attention be directed to the effect of the proposed Division upon each of the separate committees. The replies from committee chairmen varied from enthusiastic endorsement through to definite opposition. The primary thought appeared to be that the existing satisfactory committee activities of the Society should not be impaired or complicated by any new activity of the Society. It soon became evident that an extensive survey and considerable study by this committee, together with an open discussion of the matter by the Board of Direction, was highly desirable to formulate a constructive report and recommendations.

At the Jacksonville Meeting, the informal report of this committee pointed out the advantages and disadvantages, strength and weaknesses of a Division setup as against a committee setup and made it clear that at that time the committee was not prepared to recommend the formation of either a Society committee or a Division, but that the Society should be provided with a definite instrument or agency which would permit the attainment of the objectives of the proposed Division in the most appropriate manner. It was recognized that many of the professional and economic problems of the Society membership can be dealt with far more effectively and appropriately through the Local Sections than through any general agency of the parent Society, and this phase was brought out and emphasized by several of the discussions of Board members.

It is of salient interest that as a result of the discussion at Jacksonville, some of the Local Section representatives declared their intention to thoroughly review the subject with their Local Sections upon their return home. A thorough consideration of the subject by the officers and members of the Tennessee Valley Section resulted in a letter to your committee through H. L. Fruend, president, which included the surprising but definite statement that in the opinion of that Section a committee setup offered certain definite advantages over a Division setup and which stated the principle that major problems affecting the economic status of the engineer should be most effectively handled through the Local Sections rather than through a Division of the parent Society. Mr. Fruend further states: "The problem is too complex and too imminent to be dealt with in an abstract manner and the only way it can be effectively solved will be to attack concrete problems and exigencies one by one as they are brought to the attention of some group or agency of the Society. There is a strong demand for a mutual interchange of ideas, methods, and results between all the Local Sections and the parent society. There is also a strong demand for much closer contact and the assurance that back of them, in any action that may be taken, stands the national society to which they belong. While such matters might be handled by a Division, I believe the action would be too slow and involved to be of much value in keeping up with current problems. In human relations, every decision we reach is almost always a compromise of conflicting opinions. We seldom make a fair and impartial decision, but almost always suggest a compromise. I visualize this as a job in pioneering, in which we must feel our way as we go."

Since the Jacksonville Meeting, this committee has given careful consideration to the minutes of the discussion of this matter by the Board and to much correspondence received on the subject, from all of which we recommend as follows:

1. That the Board adopt the amendment to the By-Laws, notice of which was given at the April Meeting in Jacksonville and which has since been circularized to the entire membership of the Board, to wit, that the Professional Activities Committee be abolished and that the By-Laws be amended as set forth in the notice to the Board.

2. That a permanent committee of the Society be established to be known as the Committee on Professional Objectives and to consist of seven members of the Society, which members shall be selected with due regard to geographical location, interest in

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the proposed activities, standing in the profession, and qualities of leadership and willingness to assume leadership in dealing with pioneer problems in the Society; three of whom shall be members of the Board of Direction.

3. That the functions and objectives of this committee shall be:

a) To supplement and strengthen the work of the Board of Direction and the professional committees of the Society in the professional improvement of its members.

b) To concern itself actively with subjects incident to the professional practice of engineering with the objectives of developing and maintaining high standards of practice and ethics, promoting understanding among engineers and between the profession and the public, and increasing the usefulness of the profession to society.

c) To endeavor to facilitate the working together of those members of the Society who are particularly interested in the affairs and development of both salaried and employer engineers; providing an agency through which these members may express themselves more freely and effectively on professional matters.

d) To give general consideration to national and state legislation affecting the engineer and to give general consideration to the development of both the individual engineer and the development of the group, and the responsibility of the engineer to society.

e) To give particular consideration to the economic and social status of the engineer and to national and social trends affecting the same; together with consideration of all of the humanities of the engineering profession.

f) To encourage and demand a wider employment of engineers in engineering, technical works, and in the management and direction of engineering and technical works, so as constantly to increase a public demand for engineers in all types of engineering work and for technical responsibility by the engineer in management, administration, planning, and public works.

4. That the duties and responsibilities of this committee shall be:

a) To be responsible to and to report directly to the Board of Direction at least once each year upon its activities and its recommendations to the Board relative to the professional objectives and activities of the Society.

b) To serve as a contact agency for the Society between all Local Sections of the Society, facilitating the exchange of ideas relative to the handling among the Sections of specific and general problems relating to the functions and objectives of this committee.

c) To arrange and supervise discussions or forums for the membership at the quarterly meetings of the Society, selecting suitable subjects and securing appropriate speakers for such forums.

d) To sponsor the publication in appropriate manner of such articles and information as may relate to the general purposes of the committee.

e) To take such other actions as are consistent with the purposes and authority of the committee.

5. The Field Secretary of the Society shall be assigned to this work in cooperation with, and assistance to, this committee and to the Local Sections in their professional relations activities.

6. That the activities of the Committee on Professional Objectives shall be arranged to strengthen and amplify the activities of the existing committees of the Society, and not to weaken or hamper such existing committees in any respect.

7. That the By-Laws be properly amended to effectuate these recommendations.

It is recommended that the new committee be provided with the full support of the Society in the encouragement of its work, both financial and otherwise, and that after three years the committee report to the Board as to its activities and accomplishments and its conclusions and recommendations as to whether its work can best be continued and expanded by a permanent continuation of this committee or by the then formation of a Division.

8. That Director Enoch R. Needles be hereby appointed chairman of the Committee on Professional Objectives and that the President be authorized to appoint the other members of the committee at the earliest practicable date.

9. That this present committee be discharged.

Respectfully submitted,

E. P. ARNESON
W. W. DEBERARD
E. R. NEEDLES
THOS. E. STANTON, JR.
CARLTON S. PROCTOR, *Chairman*

Schedule of Fees for Structural and Foundation Engineering on Government Housing Projects Approved

BY ACTION of the Board of Direction at its Salt Lake City meeting on July 18, 1938, an approved schedule of fees on government housing projects has come into being, as affecting the charges of engineers. The work of the structural engineer and the foundation engineer in connection with the Federal Housing Administration of the U. S. Housing Authority is covered in the newly adopted schedule.

The present outcome results from action by the Board on April 18, when it adopted a resolution authorizing appointment of a committee to cooperate with the American Institute of Architects, American Engineering Council, and others in the consideration of employment of engineers and architects on public works. Conference was held with representatives of the Institute of Architects, the American Society of Mechanical Engineers, the American Society of Heating and Ventilating Engineers, and American Engineering Council. The objective was to determine the proper fees to be recommended to the federal department. The resulting schedule, approved by letter-ballot of the Executive Committee, and now by the Board of Direction, is as follows:

FEES FOR STRUCTURAL ENGINEERING AND FOUNDATION ENGINEERING ON HOUSING PROJECTS BY THE FEDERAL HOUSING ADMINISTRATION AND THE U. S. HOUSING AUTHORITY

COST OF WORK	ARCHITECTURAL		STRUCTURAL ENGINEERING	FOUNDATION ENGINEERING
	Per Cent	Dollars	Per Cent	Per Cent
$ 50,000			6	7.5
100,000	5	5,000	5	6
200,000	5	10,000	4	5.5
300,000	5	15,000	3.5	5
400,000	5	20,000	3.25	4.5
500,000	5	25,000	3	4
1,000,000	4.8	48,000	2.5	3.5
2,000,000	4.4	88,000	2	3
3,000,000	3.9	117,000	1.75	2.75
4,000,000	3.5	140,000	1.75	2.75
5,000,000	3.2	160,000		
6,000,000	3	180,000		
7,000,000	2.8	196,000		
8,000,000	2.65	212,000		
9,000,000	2.35	229,500		
10,000,000	2.5	250,000		

It will be noted that the corresponding architectural fees are given for comparison. In each case the percentage is to be applied to the cost of the work on which the service is rendered. In regard to special structural and foundation engineers' fees where there is duplication of units, the percentage may be charged against the cost of each different unit plus an additional charge for each "repeat" of each unit, rather than applying the percentage to the total cost of the work involved. Also, where such engineering services are required, some element of the architect's work may in some cases be eliminated and the extra charge may reasonably be less, in such cases, than the actual amount of the special engineers' fees. For these reasons the actual amount of the fee in each case has not been developed.

The Society has been represented in these studies by the following members: Frank A. Marston, Enoch R. Needles, and Carlton S. Proctor. The personal negotiations were delegated to Mr. Proctor.

"Headlines"

HEADLINES, a four-page bulletin to be sent monthly to all presidents, secretaries, and publicity chairmen of Local Sections, made its appearance among the Society's publications in July.

"Headlines" is a part of the intensified publicity program being carried on by the Committee on Public Information. Its purpose will be to stimulate publicity activity in Local Sections by acting as a forum in which the progress made by publicity chairmen and committees may be recorded and compared from month to month. Special attention will be given to exceptionally good examples of publicity. Suggestions as to how good publicity can be obtained will be discussed. Through "Headlines" new ideas about publicity which are being used with success in one Section will be passed on to all the Sections.

Western Local Sections Discuss Professional Activities

Classifying Engineering Positions, Improving Economic Status of Young Engineers, Encouraging Membership in Society, Local Publicity, and Efficient Administration of Local Sections on Agenda of Salt Lake City Conference

IN AN all-day conference at Salt Lake City on July 19, 1938, and just preceding the opening session of the Annual Convention of the Society, representatives of each of the Local Sections in the 11 western states met together to discuss many phases of the professional activities of the Society. The emphasis of the formal papers presented and the ensuing discussion of them was on the manner and extent of participation in these activities by the Local Sections themselves.

Each of the 13 Sections—Arizona, Colorado, Los Angeles, New Mexico, Oregon, Sacramento, San Diego, San Francisco, Seattle, Spokane, Tacoma, Utah, Wyoming—sent official representatives; most of them had one or more unofficial representatives; and a number of Sections outside the western states were represented unofficially. The conference was also addressed by President Riggs and other members of the Board of Direction, and every Section added its contribution to the many subjects that were under consideration.

In this article are presented the highlights of the Conference of Western Local Sections held at Salt Lake City on July 19. Elsewhere in the Society Affairs section will be found abstracts of two addresses on topics of special interest—"Administering a Local Section" and "Local Section Publicity."

A fuller report of the conference will be prepared in mimeograph form for distribution to those who attended and to Local Sections throughout the country.

Under the leadership of E. B. Black, chairman of the Society's Committee on Local Sections, the conference got under way following a most cordial and hearty welcome to Salt Lake by Richard A. Hart, president of the Utah Section.

RATING ENGINEERING DEPARTMENTS AND OFFICES

The first subject, concerning the rating of engineering departments and offices in cities, counties, and states with respect to salaries paid and professional qualifications required, was introduced by Mark S. Edson, secretary of the Sacramento Section. "This Section," he said, "has been one of the leaders in the salary survey for engineers." Mr. Edson compared the ten grades set up in the report of the Committee on Salaries submitted to the Board of Direction of the Society on March 31, 1937, with positions of like responsibility in California.

"While a comparison of engineering classifications of the state, Los Angeles County, the Metropolitan Water District of Southern California, the City of Los Angeles (Water and Power), the cities of San Francisco, Oakland, and Sacramento, and one public utility reveals differences in some grades, as might be expected due to geographical location, climate, and economic conditions, in general there is a surprisingly marked uniformity between the different classifications. A study of these leads to the conclusion that engineering is on a firm basis in all governmental organizations in California, and where apparent differences occur they are probably brought about more as a result of other factors not directly related thereto.

"Factors not immediately apparent are, however, working toward the ultimate benefit of the economic status of the engineer in California. In 1929 California adopted a Civil Engineers' Registration Law under which any person who practices or offers to practice civil engineering in any of its branches must be registered. The Board of Registration for Civil Engineers holds that all positions in state service above the grade of Assistant Engineer come within the terms and scope of the Act. In a recent examination given by the Division of Personnel, registration as a civil engineer was one of the prerequisites to the examination for the grade of Senior Engineer. Application of the registration law is being made as fast and as far as economically practicable, having in mind that one cannot be legislated out of a livelihood.

"One of the largest engineering organizations of the state service is encouraging its men to qualify and apply for membership in the Society and a large percentage of its employees are now members. All these factors are ultimately bound to work toward a greater degree of standardization of engineering classifications and an improvement in the economic status of the engineer.

"Thus far, unionism has not invaded the ranks of engineers in California, nor is there any serious attempt at present to force it on us."

Discussing the situation in the state of Arizona, Clyde Myers, President of the Arizona Section, stated that, Arizona being a state of small engineering organizations, they do not follow closely the classifications set up in the report of the Committee on Salaries. "However," Professor Myers stated, "the positions in the Highway Department are not under civil service and no examinations are given to fill positions. Positions are filled by the State Engineer from the best qualified men available in the state. The department has grown gradually since 1916 and all responsible positions are filled at present by well-qualified and competent men. No well-defined system of rating engineers is in use. Some of the departments make a decided effort to promote worthy men and look after their welfare, while other departments do not. It is a well-established policy of the department to employ registered professional engineers in all positions from and above that of resident engineer."

Speaking of the engineering department of the city of Phoenix, which has a population of about 50,000 within the city limits and another 50,000 in the immediately surrounding territory, he said that the department includes about 500 employees. All city employees of Phoenix are now being rated by the Civil Service Board according to the Probst system, devised by J. B. Probst, secretary of the St. Paul Civil Service Board. A new classification, that of Student Aid, has been provided which offers employment to engineering students at $100 per month provided they are registered in some engineering school.

Carl E. Painter, Assoc. M. Am. Soc. C.E., a member of the Utah Section, presented a carefully prepared paper relating to the classification or rating of any group of engineers. He stated that classification and rating of engineering departments should be the basis of all welfare work of the profession. A comprehensive classification is such a mammoth and costly undertaking that a governmental agency, such as the Bureau of Labor Statistics, should be encouraged to undertake it aided by the engineering societies. He said, "That classification would immediately and accurately differentiate engineering in its lower branches from the technical trades. Once that distinction is official, all real engineering work could be restricted to trained engineers. In the present state of affairs, there is no clear-cut line of demarcation between technical trades and the elementary processes in which young engineering graduates begin their careers. Plumbers encroach on the legitimate fields of engineers in air conditioning and ventilation; operating engineers and professional engineers occupy overlapping domains."

According to Mr. Painter, such a classification should be designed to accomplish the following essentials: (1) take care of the immediate emergency growing out of the engineers' inclusion in the Wagner Act, substituting an authoritative schedule of pay for negotiation otherwise likely to be conducted by labor unions; (2) ensure more adequate pay for all engineers by establishing fair standards, and by bringing about a fairer relation between supply and demand, excluding the untrained from initial practice and gradual induction of the trained into the profession; (3) form the basis for strong and effective, uniform registration laws; (4) serve as the basis for a natural clearing house for engineering employment; and (5) become the basis for a campaign of public education in the real nature of engineering, distinguishing engineering in the public mind from technical trades.

IMPROVING ECONOMIC STATUS OF YOUNG ENGINEERS

Speaking on the subject, "What Can the Society and Its Local Sections Do Toward Improving the Economic Status of Young

Engineers," Fred H. Rhodes, Jr., secretary of the Seattle Section, stimulated a discussion by stating that employer-engineers are in part responsible for the existing low status of their employees. He suggested the further standardization of consulting fees to eliminate some of the fee-cutting competition among consulting engineers; the education of the older engineers themselves away from the traditions of compensations for services as they existed thirty to forty years ago; and that industry voluntarily raise engineering compensation so as to eliminate the demand for union activity to accomplish the same purpose. He suggested further the stiffening of the requirements of engineering education and extending the length of the required course. These steps would decrease the number of graduates, at the same time improving their quality.

While the great railroads and utilities of the West were built in the early days by engineers many of whom were without the benefit of technical education, it should be made more and more difficult for the non-technical engineer to enter the profession and rise in it, declared John W. Howard, past-president of the Spokane Section. He looked forward to the time when graduation would be a prerequisite to practice.

Encouragement should be given by employers to graduates from engineering courses, for the investment in time and money they have made in obtaining their education, added Wayland Capwell, secretary of the San Diego Section. The officers of the San Diego Section stated that the recognition by the Society of the existence of an economic problem faced by the younger members of the profession is an important step, but only the first one. The next step is that the Society act as a clearing house of ideas and develop advice and guidance for the use of the Sections in accordance with conditions existing in their own areas.

A believer in the law of supply and demand, Prof. J. H. Dorroh, University of New Mexico, felt that too many engineers are being graduated from colleges; that a five-year course is not the answer; but that there should be a higher percentage of fatalities during the low-year course. He stated the four-year curricula should be overhauled further, and improved to turn out a better-equipped graduate.

Thought is being given by educators in this country, according to R. L. Downing, president of the Colorado Section, to granting a certificate of ability to perform subprofessional work at the end of two years of technical training in some field of engineering, and to grant a degree at the end of an additional two or three years.

Activities of Junior Forums

In Portland within the past two years a group of young civil, electrical, mining, mechanical, and other types of engineers organized a junior engineering group, related C. A. Mockmore, president of the Oregon Section. "The Oregon Section today recognizes that the Juniors of the Society must be given an opportunity to feel that they are really members of the profession and as such we have asked one of the Juniors of the Section to be assistant to our secretary. When we have our Board of Direction meeting, he sits with us. We encourage the young men to take part in the presentation of technical papers and discussions."

Some 200 Juniors belong to the Los Angeles Section. About eight years ago they organized probably the first Junior Forum of the Society. A. M. Rawn, president of this Section said, "There is an unwritten law in the group which states that the corporate members may go to those meetings but they are to be seen and not heard unless called upon to speak. It is the Juniors' meeting, definitely; it is their organization, definitely; and the Junior Forum is bringing into our particular group down there many new recruits. They meet at a time and place designated by themselves under a constitution which they have written themselves and under which they elect their own officers and set their own programs and entertainment at the time and place they desire to meet. They are welcome at our regular meetings and we never fail to introduce the speaker at the recent Junior Forum meeting and permit him or the Junior who is the secretary to briefly outline the topic which was under consideration."

The secretary of the San Francisco Section, T. J. Corwin, Jr., explained a similar organization of the Juniors of that Section and their recent studies of their own salaries. Secretary Edson of the Sacramento Section explained that the Section grants prizes of one year's dues to an outstanding student in each of three nearby Student Chapters; that the Section encourages the Juniors to put on the July and August programs at the Section's weekly luncheons; that the Section has a committee which works with the Juniors.

In summing up this part of the program, Chairman Black expressed his conviction that keeping the personnel advancing in an engineering organization where they stay year after year is a very important matter. "Sometimes," he declared, "we lose our sense of responsibility to these younger fellows toward improving their economic situation."

Encouraging Membership Appropriately

In a thoughtfully prepared talk, President Rawn of the Los Angeles Section expressed his convictions that appropriate steps should be taken to encourage applications for membership in the Society by qualified engineers. "We all have about the same ideas of what this Society should represent in engineering talent; what it should do to improve the professional status of the young engineer; what it should do to encourage membership and who should be included," he said. He believes that first efforts should be directed to Student Chapter members and other graduating civil engineers; next, to certain engineers without university training who are otherwise qualified and express a strong desire to become Juniors; next to the group of practicing engineers of moderate professional attainments whose experience may qualify them as Associate Members; and finally, to those engineers of great professional ability and reputation who are not already members. An analysis of the registered civil engineers in California who reside in District 11 indicated to him that most of the eligible engineers are already members of the Society, and that this group therefore represents a "pretty small target at which to shoot."

From this he concludes, "The best efforts should be directed toward garnering into the Society's ranks every civil engineering graduate in the United States who intends to practice the profession which he learned in school, as soon as possible after graduation, and then making Society affairs so attractive for him that he will remain an active Society member. I believe that we as corporate members should look far into the future, to a time when the American Society of Civil Engineers will have on its membership rolls the names of every responsible graduate civil engineer in the United States.

"It is not difficult to imagine the potential force inherent in such a group. It presents a theme which might be enlarged to show a day in the not too distant future when the Society could set the professional standards for practicing engineers throughout the country, when no important engineering post could be occupied by a non-member—when in fact Society membership would be a prerequisite to professional recognition. From the time he enters a university, the young engineer should be taught the strength of a well-organized engineering society."

He believes that local committees in each District should undertake an investigation which will disclose to each Director the potential new corporate members; and that appropriate steps be taken by the executives of the Society to acquaint these engineers with the value to the profession and to themselves of adding their names to the Society's roll. "However," he declared, " in the years to come it is the young graduate engineer who will establish the social and professional level of the civil engineers. It is my conviction that entrance requirements and fees, as well as annual dues for the Junior grade, should be made more attractive to the graduate engineer, and that his welfare should be made a first order of consideration in the Society." In amplification, President Mockmore of the Oregon Section stated that it is a rather poor example for an engineering college with a Student Chapter of the Society therein, to have on its civil engineering faculty men who are not members of the Society.

Local Sections can assist in attracting new members by inviting qualified men to take part in a Section's program, thus drawing their attention to the fact that they have something to contribute to the Society and at the same time that the Society can give something to them. Further, Local Sections should take on themselves the duty of actively assisting and cooperating with all the Student Chapters in their respective areas.

President R. D. Goodrich, of the Wyoming Section, cautioned that personal knowledge and acquaintance are of prime importance in undertaking to interest prospective members and that qualifications for appropriate membership must be carefully and thoroughly considered before making the attempt. License laws for registration of engineers set up requirements approximately equal to the minimum requirements for the Associate Member grade, and

the roster of licensed engineers furnishes the list to be perused. "Often," he said, "non-members who are actually qualified underestimate their attainments and overestimate the requirement standard of the Society; and I try to harmonize their views with the standard." Often at the University of Wyoming Dean Goodrich has had 100 per cent of the three upper classes in the Student Chapter there, and several times every member of the graduating class in civil engineering has become a Junior in the Society.

Secretary Rhodes of the Seattle Section stated that the Student Chapter at the University of Washington is composed of nearly 100 per cent of those eligible, and every graduate in civil engineering is encouraged to apply for membership at graduation. Professor Dorroh, at the University of New Mexico, favors the use of, and does use, all reasonable pressure on his civil engineering seniors to apply for Junior membership. He believes that the seniors thus encouraged will later be thankful for the insistent interest taken in them.

Administering a Local Section

In approaching the subject of Local Section administration, E. L. Warner, president of the Tacoma Section, stressed the necessity of creating an atmosphere of friendship and congeniality at Local Section dinners; felt that details of the business of a Section should be handled by its directors; and recommended a minimum of committees composed of but few members. A digest of his remarks appears elsewhere in this issue.

Concurring in most of Mr. Warner's thesis, President Downing of the Colorado Section disagreed to the extent of recommending many large committees. "The more men that can be interested in the Section's activities the stronger the Section is going to be. Perhaps a one-man committee will function more efficiently, but we should give a number of men an opportunity to take an active part in Section affairs. The greater the number who are given the opportunity to have a voice in the management of a Section, the happier they will be and the greater will be their cooperation." Prof. Downing emphasized the need for a good meal in a congenial atmosphere as an essential part of a Local Section meeting. He spoke of the excellent organization of the Junior Association of the Colorado Section and their whole-hearted participation in the direction and management of the Section. In closing he said, "I feel that the officers of a Section should be largely a directing committee to direct the work of the Society locally, and that each member should be brought into the Society affairs as he shows his willingness and his ability to participate."

Local Section Publicity

The San Francisco Section has been unusually successful in its program of publicity. An address prepared by Ralph G. Wadsworth, president of the Section, was presented by Secretary Corwin. Mr. Wadsworth divided the topic into its two parts: publicity for the members, or inside publicity; and publicity for the citizens of the community, or outside publicity. His address is extracted elsewhere in this issue. Mr. Corwin added that while the Section for several years expended $25 a month for a publicity agent, since 1937 all the publicity has been developed by the Section's Publicity Committee with equally good results.

Newspapers and the press are interested in the work of civil engineers because practically all of it is connected with the building and developing of the community, according to Thomas M. McClure, president of the New Mexico Section. If the Society's Publicity Manual is followed closely in the preparation of press releases, the news editors will be receptive to the use of copy prepared for them.

For inside publicity purposes, the Los Angeles Section uses a column in a monthly publication, *The Southwest Builder*, which goes out to most engineers and contractors in the state. For 25 years the Texas Section has published *The Engineer*, which goes to all engineers in the state.

Secretary Seabury interested the conference with a description of the program being inaugurated by the Society's Committee on Public Information in an effort to intensify the publicity by Local Sections themselves, for the citizens in their own towns, in their local newspapers. The first copy of "Headlines" was shown—a photo-offset pamphlet which is to appear monthly, "to report the most timely news of what is being done by Local Sections toward promoting harmonious relations between the public and the profession of civil engineering." He believes there is to be found in the membership of each Section some one who is interested in writing news articles for local consumption concerning civil engineers and their work; and he expressed the hope of the committee that each Local Section would find such a man and put him to work.

Federal Public Works Department Impracticable

So States Special Committee Report to the Board of Direction; Coordinating Agency Recommended Instead

AFTER extensive discussion at its July 18 and 19 meeting at Salt Lake City, the Board of Direction ordered that the following report be printed for the benefit of the membership and that informed discussion be invited.

June 22, 1938

To the Board of Direction
Gentlemen:

Your committee, appointed by President Riggs on February 16, 1938, ". . . to conduct a thorough study of all problems relating to the reorganization of the Federal Public Works. . ." has made a careful review of the documentary evidence developed during the past twenty years, has examined material applicable to more recent years, and has interviewed a number of responsible officials of the several federal agencies engaged in engineering enterprises as well as prominent engineers in private practice. As a result of these studies, your committee has arrived at the following conclusions:

I. The creation of a Federal Public Works Department, containing an essential part of the agencies carrying on engineering work, is practically impossible of attainment, would be unwieldy, would be of doubtful advantage as regards efficiency or economy, and would represent a concentration of power of dangerous proportions.

Therefore, it is recommended that the American Society of Civil Engineers refrain from lending its support to proposed legislation providing for such a department.

II. There is strong evidence that a reviewing and coordinating agency may prove effective in the establishment of priorities, in the prevention of major and minor overlapping of functions or conflict of policy, and in the allocation of funds.

Therefore, it is recommended that the American Society of Civil Engineers seriously consider the endorsement of the creation of such an agency.

Discussion of Conclusion I

The almost unanimous preponderance of the considerable informed opinion to which we have had access, holds that such a Department of Public Works cannot be created without excluding from it several of the larger and more important agencies engaged in engineering work. These agencies have been traditionally opposed to inclusion and there is no doubt that their opposition would be sustained because of political pressure both from inside and outside the government.

The prevailing opinion that we have encountered is to the effect that it is exceedingly doubtful if any saving in money, increase in efficiency, or expedition of time would result. We agree with this opinion.

It is our belief that much of the more obvious and apparent waste and lost motion is in the domain of relatively small enterprises and, while we do not condone it, we believe that it is largely the reason for the agitation for a separate department.

Discussion of Conclusion II

On the other hand, it is obvious to anyone who studies the question at close range that far more waste and inefficiency arise from a lack of preliminary review and coordination in the realm of large undertakings. Our observations lead us to believe that often the policies and efforts of one agency are at cross purposes with those of another, and that the work of one frequently nullifies that of the other. We believe that many of these important deficiencies may be eliminated or alleviated by a reviewing and coordinating agency such as that to which we invite your consideration. Indeed, much

has recently been accomplished in this direction by at least one agency of the government working in the field of water resources.

It is also our firm belief that one of the most important features of such an agency would be its ability to shield administrative officers from political pressure groups.

In view of the above, your committee recommends for your serious consideration, the endorsement of a reviewing and coordinating agency. As to the structure of this agency, aside from the fact that it obviously must consist predominantly of the administrative officers of the government, we have only one suggestion to make, and that is, that there be included in its membership a group of prominent men not connected with the government, one of whom shall act as chairman of the agency.

In our judgment, such an agency will serve to eliminate the chaotic condition now prevalent and accomplish the following:

1. Coordination and cooperation between the bureaus of one department.
2. Coordination and cooperation between the various departments.
3. The elimination of the action of political pressure groups.
4. The diagnostic character of such an agency will tend to eliminate worthless projects and will place the merited ones in their proper priority.
5. With its close contact with all bureaus interested in engineering activities, it would automatically gather a fund of factual information from which there may eventually result definite recommendations towards the elimination or regrouping of existing agencies.
6. In acting as a clearing house, it will be of inestimable value to the Bureau of the Budget in determining priorities and recommendations for the allocation of funds.

Respectfully submitted,

By DANIEL C. WALSER, *Chairman*

S. W. SAWIN J. TRUEMAN THOMPSON

Allocation of Members Not Resident in North America

Salt Lake City Convention, July 20, 1938, Passes Constitutional Amendment to Ballot, After Hearing Majority and Minority Reports; with Other Business

IN ACCORDANCE with constitutional requirements, a meeting of the Society was held on Wednesday morning, July 20, 1938, at the time of the Annual Convention in Salt Lake City, Utah, being called to order immediately following the general technical session. President Riggs turned the meeting over to Vice-President Gowdy, who presided.

Under the heading of unfinished business, a communication was expected from the committee authorized at the time of the 1938 Annual Meeting, with instructions to report on the proposed amendment to Article VII of the Constitution, designated as Proposal No. 5, and having to do with the allocation, for the purpose of nominating Society officers, of members resident outside of North America. The Secretary had received two documents, a majority and a minority report. Both were read to the meeting as follows:

MAJORITY COMMITTEE REPORT

To the Members of the American Society of Civil Engineers

Gentlemen:

The committee appointed by the President, in accordance with the action of the meeting of the Society on January 19, 1938, to report on a proposed amendment to the Constitution, indicated as Proposal No. 5 (amended), respectfully submits its report as follows:

Proposal No. 5 (amended) reads as follows:

> "Each member shall be allocated as resident in the district within which his mailing address on record with the Society on the preceding January 1 is located. Members not residing in North America shall be allocated as resident in District No. 1. The Board of Direction, however, may allocate any member, with his consent, as resident of such other district as, in its discretion, it shall designate."

It is clear that the proponents of this proposal had in mind the same objective as that involved in Proposal No. 4, upon which the membership of the Society voted during the early part of this year, and which was rejected by a large majority. This purpose has been stated rather clearly in the motion passed at the business meeting of January 19, that is, "that every member residing outside of North America have the privilege of choosing the District to which he shall be allocated, and shall be so allocated provided it meets with the approval of the Board of Direction."

Proposal No. 5 (amended) as above does not clearly reflect this intention, because of the use in the last sentence of the words "any member" instead of the words "any member not residing in North America."

It is the opinion of your committee that there is no occasion to change the provisions of Section VII of the Constitution, with respect to members residing in North America, and the committee is therefore recommending further amendment to Proposal No. 5 to restrict the change to members residing outside of North America. The committee is also of the opinion that for administrative reasons the initiative in changing the allocation of any such non-resident member, if such change were to be made, should rest with the member and not with the Board of Direction, and is proposing re-wording of the last sentence to bring this about and also to make the procedure definite.

The proponents of Proposal No. 5 appear also to have taken note of a statement contained in the letter of counsel dated November 18, 1937, as follows:

> "the ballot of such non-resident could not be counted, as he does not reside in the District. To some extent this inconsistency exists in the Constitution in its present form."

Proposal No. 5 (amended) apparently is expected to correct this inconsistency by the use of the phrase—"shall be allocated *as resident* in District." The committee was in doubt as to whether this change fully removed the question raised by counsel in the letter referred to and again referred the matter to counsel for opinion. As stated in the opinion of counsel dated June 21, the proposed revision of phraseology "will clarify and correct" the inconsistency.

Your committee has carefully canvassed the situation with respect to our members resident outside of North America and has been informed of only one situation where any group of such members might desirably be allocated to a district other than District No. 1. This is the situation of the members in the Territory of Hawaii, a canvass of whom some years ago by the then Vice-President Walter L. Huber indicated their desire to be allocated to District No. 13.

If this condition still exists, or if there are other areas outside of North America in which the situation of the members would be improved by allocation to some district other than District No. 1, your committee believes that it might be accomplished by an amendment to the Constitution which would empower the Board of Direction to divide the territory occupied by the membership, not only of North America, but of the world, into districts. However, the committee does not recommend an amendment of this type.

In the opinion of your committee no sufficient reasons have been presented, nor do any exist which would warrant a change in the Society Constitution as contemplated by Proposal No. 5 (amended). No change in the Constitution should be made unless there is to be a definite gain.

Your committee recommends:

1. That Proposal No. 5 as amended, and after further revision, be submitted to letter ballot with a recommendation that it do not pass.
2. That, before being submitted to letter ballot, Proposal No. 5 (amended) be further amended to read as follows:

"Each member shall be allocated as resident in the district within which his mailing address on record with the Society on the preceding January 1, is located. Members not residing in North America shall be allocated as resident in District No. 1, except that any such member not residing in North America may, upon his specific written request and for reasons stated in such request, be allocated as resident to any other district, by the Board of Direction, at its discretion."

Respectfully submitted,
COMMITTEE ON PROPOSAL NO. 5

R. E. BAKENHUS GEORGE W. SIMONS, JR.
WALTER L. HUBER W. W. HORNER,
June 29, 1938 R. L. MCNAMEE *Chairman*

MINORITY REPORT ON PROPOSAL NO. 5

Dr. Henry E. Riggs
President, Am. Soc. C.E.

Dear Sir:

It appearing that a majority of the members of the committee selected by you to report on Proposal No. 5 for amending the Constitution of the American Society of Civil Engineers will recommend that said proposal do not pass, I present for consideration at the business meeting of the Annual Convention the following minority report recommending passage of the proposal in amended form.

Objective

Proposal No. 5 had for its original objective a further step in the recent trend toward making the governing officials of the Society, particularly the members of the Board of Direction, more representative of and more directly responsive to the corporate membership. This trend from autocracy to democracy has been referred to by some as the "democratization" of the Society and was recently signalized by giving Local Sections a larger place in the sun.

The Constitution provides for equal representation of districts on the Board of Direction on the basis of residence (mailing address) in the several districts, except in District No. 1. The disturbing element in District No. 1 is the arbitrary allocation to that district, wholly regardless of their wishes, of between five and six hundred members not resident in North America. Proposal No. 5, as originally presented, was intended to abolish this gratuitous allocation and permit each non-resident member, for the purpose of nominations, to designate the District of his choice, if any, in order that he might participate in the selection of members of the Board of Direction therefrom. With this objective I am in entire sympathy. I believe that the desires of the non-resident members should be respected in this matter.

The Allen Amendment

Somewhat hastily, at its annual meeting in January, the Society adopted the Allen amendment to Proposal No. 5, which in effect, restored the arbitrary allocation of non-resident members to District No. 1. It also provided that the Board of Direction might allocate any member, with his consent, to any District whatever, this latter provision being applicable to resident as well as non-resident members. I am opposed to both of these changes—the first, because it reverts to the autocratic as opposed to the democratic form of government; and the second, because I have no desire that the Board of Direction should have power to allocate me to any District, with or without my consent. I want the Constitution to provide that I, myself, regardless of the Board of Direction, shall select the District in whose affairs I shall participate (1) when, practicable, by residence or mailing address (which is of my own choosing), or (2) when the rule of residence is impracticable, as in case I should become a non-resident member, by my own written request or demand.

What Do Non-Resident Members Desire?

The returns from a circular letter sent to 654 non-resident corporate members show that they overwhelmingly do *not* desire to have the right to vote on the nomination of a Director or a Vice-President from any District or Zone in North America. The letter provides that failure to express a preference would be interpreted as equivalent to an expression of desire not to participate in nominations. With this spur to response it is safe to assume that all who desire to participate have been heard from. Sixty-two responded positively that they do not desire to participate in nominations, and several good reasons for this stand were presented. Only 70 expressed a desire to have the right to participate in nominations, and 2 of these did not indicate the District or Zone of their interest. The preferences of the other 68 were scattered among 13 of the 16 Districts, 37 preferring Districts other than No. 1. Only 31 non-resident members expressed a desire to have the right to participate in the nominations of District No. 1; but more than 650 are nevertheless allocated to that District under the present Constitution and can exercise a right of franchise nowhere else. Is this democracy? Is this representative government? With such an expression from the corporate members directly affected, the conclusion is obvious: Let non-resident members who so desire participate in nominations in the Districts they designate; and let those who desire *not* to be arbitrarily allocated to a District in whose affairs they have no interest, have their wish also.

Equal Representation

The Committee on Proposal No. 4, under Chairman R. E. Bakenhus of New York (who is also a member of the Committee on Proposal No. 5) reported to the Annual Meeting in January 1938 that, if the "foreign" members were taken out of District No. 1, "the number of Directors for District No. 1 would be reduced from four to three." This calls attention to the fact that, by reason of arbitrary allocation of non-resident members to District No. 1, that District, limited to an area within 50 miles of a central point in New York City, is given a voting power on the Board of Direction out of all proportion to its membership. Why should District No. 1 with between 1,800 and 1,900 corporate members be represented by four Directors when Districts Nos. 11 and 13, together having nearly the same membership, or Districts Nos. 4 and 5, together having but slightly smaller membership, are represented by only two? Or, if you please, why should these four Districts, with 3,094 resident corporate members, be represented on the Board by no more Directors than District No. 1 with only 1,855? Is this democracy? Is this equal representation? Admiral Bakenhus has presented a cogent reason why the original objective of Proposal No. 5 should be consummated; that is, unless autocracy is favored over democracy in Society government.

Recommendation

In order to accomplish effectively the original objective of Proposal No. 5, I recommend to the Annual Convention that said proposal be now further amended and be sent to letter-ballot in the following form with the recommendation that it do pass:

Proposal No. 5

Amend Article VII, Section 1 of the Constitution by striking out the last two sentences of the first paragraph, reading "Each member shall be counted in the district within which his mailing address on record with the Society on the preceding January 1, is located. Members not residing in North America shall be allocated to District No. 1" and insert in lieu thereof the following:

"For the purpose of this article, Corporate Members whose mailing addresses on record with the Society on the preceding January 1 are within the boundaries of Districts shall be deemed to reside in such Districts; and each Corporate Member whose mailing address is not located within the boundaries of any District shall be deemed to reside in the District he shall designate by written communication to the Secretary."

Respectfully submitted,
HERMAN STABLER
July 16, 1938 *Member of Committee*

The action of the Society by motion duly seconded and carried unanimously was that the majority report be received and that its recommendations be adopted; that is, that the amendment be further amended as suggested in that report and be passed to ballot with the recommendation that it do not pass.

* * * * * *

Upon call for new business, an inquiry was made from the floor as to the extent to which Technical Divisions or Local Sections may undertake to speak for the Society as a whole. Answer was made that such units should speak their minds freely to the Board of Direction for its information but that the Board—in its capacity as the legally elected officers of the Society and as such having the responsibility of conserving the interests of all of the Society's members, nearly 16,000 in number—was the only unit which could

speak for the Society, except as it might authorize other units, committees, or individuals to do so in its behalf.

There being no other business, the meeting was adjourned.

GEORGE T. SEABURY
Secretary

EDITOR'S NOTE: Ballots covering this proposed amendment to the Constitution were issued to members on August 15, 1938. They will be canvassed on October 12, 1938.

Tellers' Report on First Ballot for Official Nominees

New York, N.Y.
August 1, 1938

To the Secretary
American Society of Civil Engineers:

The tellers appointed to canvass the First Ballot for Official Nominees report as follows:

For Vice-President, Zone II	
Richard Khuen, Jr.	317
Ineligible candidate	18
Scattering	54
Void	2
Blank	39
Total	430
For Vice-President, Zone III	
Clyde T. Morris	191
Theodore A. Leisen	141
Charles B. Burdick	128
James L. Ferebee	75
A. F. Reichmann	73
Charles H. Paul	62
Scattering	52
Blank	15
Total	737
For Directors, District 1	
(Two to be elected)	
Harold M. Lewis	195
H. W. Hudson	194
Ineligible candidates	84
Scattering	54
Total votes	527
Blank	13
Total	540
Actual number of ballots received (1/2 of above figure)	270
For Director, District 4	
Sanford W. Sawin	133
Scattering	7
Blank	4
Total	144
For Director, District 11	
Charles T. Leeds	121
A. M. Rawn	34
Ineligible candidate	37
Scattering	17
Total	209
For Director, District 14	
Robert B. Brooks	75
Edward R. Stapley	39
Scattering	9
Void	1
Blank	6
Total	130
For Director, District 15	
Edward S. Bres	161
Ineligible candidates	14
Scattering	14
Total	189
Ballots canvassed	1,835
Ballots withheld from canvass:	
From members in arrears of dues	100
Without signature	2
With printed signatures	2
Total	104
Total number of ballots received	1,939

Respectfully submitted,
RALPH H. MANN, *Chairman*

G. H. Seybolt	Howard Holbrook
Joseph Fertik	Albert P. Loriot
A. C. Josephs	Carl A. Arenander
George R. Latham	Bernard Gaber
Bernard L. Weiner	H. K. Gatley
Clifton W. Bolieau	E. M. Whitney

Tellers

Publicity for Sixty-Eighth Annual Convention

ORCHIDS to the Utah Section for the enthusiasm it aroused in Salt Lake City for spreading news about the Sixty-Eighth Annual Convention! As a result of the fine selling job done by the local committees on arrangements and publicity, the three Salt Lake City newspapers—the Salt Lake Tribune, a morning paper, and the Telegram and Deseret News, afternoon papers—cooperated wholeheartedly in giving space to the Convention. These papers carried front-page stories and numerous photographs of the speakers and Society and Section officers.

Three star reporters—O. N. Malmquist, of the Salt Lake Tribune, Ray Richards, of the Telegram, and Paul V. C. Whitney, of the Deseret News—let nothing escape them in covering the general and technical sessions. They also found time to interview a number of past and present officers and members on subjects of general civil engineering interest.

Up to August 10, 2,233 column inches of space had been accounted for in the 235 clippings appearing in 150 newspapers in 131 cities of 32 states. Perhaps it would be more graphic to say that this material would fill a 14-page newspaper, with nothing else in it. Of the 2,233-column-inch total, 1,300 column inches were published in the three Salt Lake City newspapers, and of the latter material 523 column inches (or 26 columns) were devoted exclusively to photographs of officers and speakers and their lady guests.

Obviously the Utah Section did an unusually fine piece of work. And the Society, throughout the country, reaped the benefit.

Appointments of Society Representatives

RUDOLPH C. BECKER, Assoc. M. Am. Soc. C.E., will serve as the Society's representative on the Sectional Committee of the American Standards Association on Safety Code for Mechanical Refrigeration.

JAMES W. LYTEL, M. Am. Soc. C.E., has been appointed to fill the vacancy on the Society's Committee on Flood Control caused by the resignation of A. W. NEWTON, M. Am. Soc. C.E.

ENOCH R. NEEDLES, M. Am. Soc. C.E., has been reappointed to serve as one of the Society's representatives on the Engineers' Council for Professional Development for the three-year term expiring October 1941.

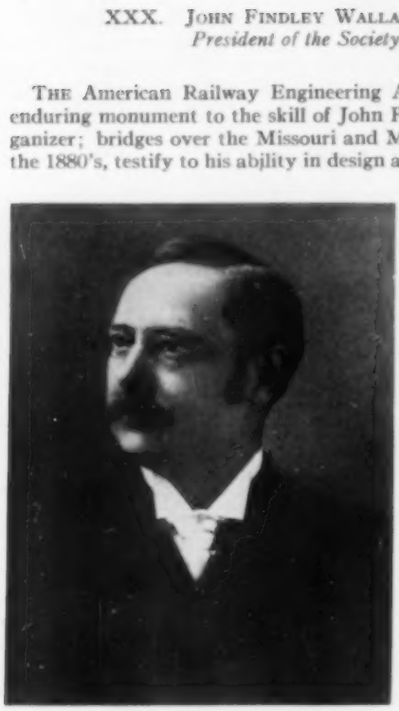
J. J. YATES, M. Am. Soc. C.E., has been reappointed to serve as one of the Society's representatives on the Engineering Societies Library Board for the three-year term expiring October 1941.

Early Presidents of the Society

XXX. JOHN FINDLEY WALLACE, 1852–1921

President of the Society, 1900

THE American Railway Engineering Association stands as an enduring monument to the skill of John Findley Wallace as an organizer; bridges over the Missouri and Mississippi rivers, built in the 1880's, testify to his ability in design and construction; and the history of the Illinois Central Railroad, the Panama Canal, and numerous corporations and commissions, bear witness to his executive and administrative talent. Few careers, in fact, portray more forcefully than his the many-sidedness of the profession of engineering.



JOHN FINDLEY WALLACE
Thirtieth President of the Society

John Findley Wallace was born at Fall River, Mass., in 1852, but his childhood and youth were spent in Illinois, in a rather unusual combination of academic, religious, and semi-pioneer conditions. His father was the founder of Monmouth College (1856), an institution sponsored by the United Presbyterian Church, and one of the oldest schools in the state. It was there that Wallace received his college training. However, he dropped those studies that he did not think were necessary—"among which were Hebrew and one or two things of a theological nature"—so that he did not graduate. (Years later the college granted him the honorary degree of LL.D.) He supplemented his college work with private instruction in engineering, and at the age of nineteen went to work with the Corps of Engineers on the improvement of the Upper Mississippi River.

WALLACE ENTERS RAILROAD WORK

After five years on this work, and three as a county surveyor, he was put in charge of the location, construction, and operation of a railroad from Peoria to Keithsburg, Ill., which afterward was merged with the Iowa Central Railroad Company. In the latter organization, Wallace was chief engineer of construction from 1883 to 1886. During that time he designed and constructed transfer facilities across the Mississippi River at Keithsburg, and was associate engineer on the construction of a bridge across the Mississippi at the same point.

There followed a period with the Atchison, Topeka and Santa Fe (1887–1889) as bridge engineer on the extension of that company's line between Chicago and Kansas City. Of special interest in this connection was the bridge over the Missouri River at Sibley, Mo., on which he was resident engineer. This structure involved the sinking of caissons under air in a river noted for its swift, treacherous currents and sudden, unexpected rises. It was one of the outstanding projects of its day, and was thoroughly described in TRANSACTIONS for 1889. The account is well worth reading.

From 1889 to 1891, Wallace was associated with E. L. Corthell, later President of the Society, in Chicago, and had charge of the construction of a joint entrance into the city of Chicago for the Atchison, Topeka and Santa Fe Railroad Company and a western connection for the Illinois Central Railroad Company. He acted as associate with Mr. Corthell during this time on the foundation work of the Merchants' Bridge over the Mississippi River at St. Louis, Mo., and was likewise associated with him on various other works, including a proposed bridge over the Mississippi in the vicinity of New Orleans, La.

In 1891 Wallace was appointed chief engineer of the Illinois Central Railroad Company, and immediately rendered distinguished service in the reconstruction of its terminals within the city of Chicago for the purpose of meeting traffic conditions arising through the location of the World's Fair adjacent to the tracks of the company. In this connection, he was largely influential in the beginning of track elevation in Chicago, the Illinois Central through his counsel and advice being the first railroad company to enter into a contract for track elevation in that city.

During his service as chief engineer, the Illinois Central Railroad Company went through a period of great development in both construction and maintenance work. Many branches and auxiliary lines were built, and on many parts of the line grades were reduced, alinement was improved, and second track was built. Many large yards were constructed as well as large terminal facilities in New Orleans, St. Louis, and other places, and the general condition of the road was greatly improved.

In 1898 Wallace was transferred to the executive department, serving with the various titles of assistant vice-president, assistant general manager, and general manager, until 1904, when he left the Illinois Central to become chief engineer of the Isthmian Canal Commission. Later he served as a member of that commission, and was also a member of the executive committee and vice-president and general manager of the Panama Railroad and Steamship Company.

ORGANIZING CONSTRUCTION WORK ON THE PANAMA CANAL

There can be no doubt that to Wallace was largely due the credit for the organization originally built up for the construction of the Panama Canal. His knowledge of railroad transportation, a feature of prime importance, coupled with his wide and varied experience in engineering construction, rendered him peculiarly competent to organize and conduct a work of such great magnitude.

In 1905 he relinquished his work at Panama and returned to the United States. On account of his reticence, his full reasons for resigning were never made public. It was known, however, that he was not in accord with the policy of the Administration in certain essential features connected with the plans and conduct of the work, notably the determination not to construct a sea-level canal.

In 1906 he acted as confidential adviser to the president of the Chicago and North Western Railway Company in the design of its new passenger terminals in Chicago, and very shortly thereafter he went to New York City to become president of Westinghouse, Church, Kerr and Company, at that time one of the largest engineering and construction organizations in the United States. It was engaged in the design and construction of engineering works of great magnitude in different parts of the United States and Canada, including the construction of terminal and dock facilities and large hotel, office, and factory buildings. During the ten years he directed the activities of this organization, it is estimated that its expenditures averaged more than $10,000,000 a year.

In 1913 Wallace was retained by the city of Chicago in an advisory capacity in connection with the granting of a franchise to the Union Station Company. This led to his permanent employment by the city as chairman of the Chicago Railway Terminal Commission, a body of distinguished engineers, lawyers, and members of the city council, which was organized to act in an advisory capacity to the city in all matters relating to railroad terminal facilities of magnitude within the city limits.

Wallace's unusual diplomatic ability, coupled with his experience in engineering and administrative capacities, well fitted him to harmonize the many conflicting interests involved in the great work of putting on a stable basis the relationship between the city of Chicago and the great railroad companies with which it was involved in transactions during this period. To his efforts, in no small measure, must be attributed the satisfactory solution of the Union Station problem and the arrangement made between the city, the South Park Commissioners, and the Illinois Central Railroad Company, culminating in what is known as the "Lake Front Ordinance," covering the extensive improvements required for the construction of a great system of parks on the Lake front by the South Park Commission; the relinquishment of the railroad's riparian rights; the electrification of its lines within the city limits; the building of a great passenger station; and the dedication for the benefit of the U. S. Government of a great harbor district.

From 1915 until his death, Wallace acted as consulting engineer, director, and member of the executive committee of the Taylor-

Wharton Iron and Steel Company. For five years he was a member of the Committee of Harbors and Shipping of the Chamber of Commerce, State of New York. He was also for a time chairman of the board of directors of the Southern Oil and Transport Corporation and chairman of the board of directors of the Century Oil Company. During the World War he served as a member of the Transporation Committee of the National Petroleum Advisory Board.

Wallace's death occurred in Washington, D.C., in 1921, while he was attending Senate committee hearings in connection with the Board of Economics and Engineering, of which he was a member. He was survived by his wife and two children. One of them, Harold Ulmer Wallace, is now a member of the Society.

As has been indicated, Wallace was one of the founders of the American Railway Engineering Association. In fact, the writers of his memoir (in TRANSACTIONS, 1922) state that it was largely to the acumen and diplomacy which he evidenced in cooperating with other members of his profession in the building up of this organization that its great success has been due. He served as its first president, and was also twice president of the Western Society of Engineers.

It is said that Wallace had a quality of cementing friendships to a rare degree. His characteristics in this connection were well illustrated in an address given by him to the graduating class of Monmouth College in 1916, in which he said: "My first advice to you would be to cultivate friends. Begin with your own family circle and let your friendships extend to include your neighbor, your city, your state, your country, and finally broaden it out to include and embrace humanity. Other things being equal, the measure of your success will depend upon your friendships."

ADDRESS AT THE SOCIETY'S CONVENTION IN 1900

Quite often the remarks of the Society's Presidents in their addresses at the Annual Conventions give an insight into their concept of the profession. This was especially true in the case of Wallace, and the following quotation provides a fitting close for this sketch. It is of interest to note that the 1900 Convention, at which his address was delivered, was held in London, where the Society was the guest of the Institution of Civil Engineers of Great Britain.

"Among the underlying qualities necessary to the highest success in our profession are: the ability to accurately observe natural phenomena; a faculty of mentally picturing things in their proper relation to each other; good business judgment and sense; a careful study of business methods; tact, which to some men means so much and to others so little; personal loyalty, not only to the enterprise in which he is engaged, but also to his immediate superior; and, above all, the engineer should not neglect the fact that 'the proper study of mankind is man.'

"In the technical schools of the present day much time is spent in considering the strength of materials, the applied mathematics in the investigation of forces; but nothing in relation to the mental and moral constitution of man, which is the live material that engineers must use in fitting Nature's raw products to the work in hand. There is too much of a tendency among engineers today, as ever, to consider the profession entirely a materialistic one, and to confine the education of the young engineer to a knowledge of materials and their uses, to the exclusion of the mental and spiritual.

"The prevailing law of matter is inertia. The prevailing principle of the engineering profession is life. The application and direction of the life principle to matter, in order to overcome its inertia, change its form, and adapt it to our needs, is the problem. Neither factor can be ignored, above all the life principle. There is too much of a disposition on the part of our profession to value too highly what are the tools of our trade; to forget for a moment that they are simply tools, and fail to appreciate the energizing factor and the mental make-up of the engineer.

"It is not the most expert bookkeeper who becomes the most successful banker or merchant, no matter how important carefully kept accounts may be to the success of a bank or mercantile business. It is not the surgeon who has the finest set of instruments, or even the greatest knowledge of their uses, who is necessarily the most successful. It is not the lawyer who has read the most law, but the one who can discriminate and apply his knowledge to the case in hand, who is the best jurist. So it is not the engineer who is the most expert mathematician, the finest draftsman, or who may design and calculate the most beautiful structure, who is the most successful.

"The true engineer of today is the one who, seeing a necessity arising in the onward march of civilization, can think out its solution, and carry out the scheme as a whole to a successful issue; at the same time convincing his fellow men of the necessity for the work, the efficiency and economy of his design, and his own ability to accomplish the desired result.

"Our works should increase the comforts of mankind, 'cause two blades of grass to grow where one grew before,' enable persons and property to be carried greater distances in shorter periods of time, with increased comfort and convenience and at the least possible expense. The economy of labor should be the ultimate object to be attained.

"The best engineer is not necessarily the one who will design and construct an elaborate bridge across a mighty river, but the one who will design and construct such a bridge so as to give the greatest amount of facility for transportation over it at the least possible expense. That engineer is the best who designs and constructs, results being equal, in such a way that the interest on capital invested, together with maintenance charges and operating expenses, are a minimum. It is certainly poor engineering to construct works so massive, and with such a surplus of strength and solidity, that the interest on the original amount invested far exceeds the cost of repairs, renewals, and interest on a differently designed work which would perform a similar service."

[This sketch is in the main an abstract of the comprehensive memoir appearing in TRANSACTIONS for 1922.]

In and About the Society

WITH the approval of the Board of Direction, the flags of the Construction Division Post of the American Legion have been placed on permanent display in the Board Room at Society Headquarters. There are probably few other places where these banners could be viewed as frequently by men to whom they have a special significance. During the World War hundreds of members of the Society, from all parts of the country, were in the service of the Construction Division; and a large number of them are now active in the Legion—either in Post No. 10 or elsewhere.

* * * *

ANOTHER step toward the initiation of the J. Waldo Smith research fellowship in hydraulics has been taken with the appointment of a special committee to administer the award. The committee consists of Thaddeus Merriman, chairman; Charles M. Allen; and Frank E. Winsor. The purposes and provisions of the fellowship, which is to be financed from the proceeds of the J. Waldo Smith fund, were outlined in the March issue of CIVIL ENGINEERING.

* * * *

A "CERTIFICATE of appreciation" has just been awarded the Society by the Franklin Institute for its participation, through an official delegate, in the extensive dedication ceremonies of the Benjamin Franklin Memorial Building in Philadelphia. Incidentally, the Society's representative was Benjamin Franklin, M. Am. Soc. C.E. His account of the dedication appeared in the July issue of CIVIL ENGINEERING.

* * * *

ANOTHER installment in the pins-that-came-back serial: On July 4, F. M. Bowen, M. Am. Soc. C.E., lost his badge in Bryce Canyon, Utah. The date and place were definitely known. Just 11 days later J. C. Stevens, M. Am. Soc. C.E., spotted it tramped in the mud in an automobile shed at Hot Sulphur Springs, Colo.—some two or three hundred miles from where it disappeared. Can anyone match this for sheer coincidence?

* * * *

FROM Buenos Aires, Argentina, comes an item that demonstrates the international character of the Society. T. T. Knappen, M. Am. Soc. C.E., visiting in the Argentine capital in June, was entertained at a dinner given at the City Hotel there by eight of the 15 resident members. His hosts were Ralph Dominguez, Carlos Wauters, Emilio Lenhardtson, Georg Carl Franck, Wilson Sidwell, Juan A. Valle, Esteban Terradas Ylla, and Albert A. Agramonte.

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State, and Local Engineering Societies Located in 40 States

SUMMARY OF NATIONAL LEGISLATION

THE staff of American Engineering Council has prepared a review of the actions of the Seventy-Fifth Congress for the special session, November 15–December 21, 1937, and for the regular session, January 3–June 16, 1938, on legislative matters of interest to the engineering profession. The following extracts from that summary include the principal actions of particular concern to civil engineers. Bills that failed of passage are not included.

Roads

Public No. 584 (H. R. 10140, Mr. Cartwright of Oklahoma): To amend the Federal Aid Road Act, etc.

Appropriations are authorized to continue the federal-aid road program for fiscal years 1940 and 1941; $158,500,000 for 1940; $191,000,000 for 1941. Definite amounts are allotted to federal-aid highways, secondary or feeder roads, elimination of grade-crossing hazards, forest roads, public land roads, roads in national parks, national parkways, and roads through Indian reservations.

As carry-over from prior authorizing statutes, it is estimated there will also be available by January 1, 1939, $150,000,000 for the various kinds of roads specified above, $80,000,000 of which is for federal-aid roads, $20,000,000 for secondary roads, and $30,000,000 for grade crossings. $8,000,000 is authorized for use as emergency fund to reconstruct highways, bridges, etc., damaged by floods.

Vehicular Tunnels

Public No. 725 (S. 4041, Mr. Smathers of New Jersey): Granting the consent of Congress to the State of New Jersey and the Commonwealth of Pennsylvania to enter into compacts for a vehicular tunnel under the Delaware River.

Flood Control

Public No. 761 (H. R. 10618, Mr. Whittington of Mississippi): Authorizing the construction of certain public works on rivers and harbors for flood control, and for other purposes.

The Act provides that, "Hereafter, Federal investigations and improvements of rivers and other waterways for flood control and allied purposes shall be under the jurisdiction of and shall be prosecuted by the War Department under the direction of the Secretary of War and supervision of the Chief of Engineers, and Federal investigations of watersheds and measures for runoff and waterflow retardation and soil erosion prevention on watersheds shall be under the jurisdiction of and shall be prosecuted by the Department of Agriculture under the direction of the Secretary of Agriculture, except as otherwise provided by Act of Congress."

Authorizes numerous flood control projects and appropriations for a five-year period of $375,000,000, ending June 30, 1944, and in addition provides $10,000,000 for examinations and surveys by the War and by the Agricultural Departments and $1,500,000 for the Federal Power Commission.

The provision of the 1936 Flood Control Act, that penstocks may be installed in all flood-control reservoirs on recommendation of the Chief of Engineers, with approval of the Secretary of War, is amended to make it mandatory that they be installed by the Secretary of War when approved by him upon the recommendation of the Chief of Engineers and the Federal Power Commission.

Under the Act the federal government is to pay the entire cost of dams, reservoirs and channel improvements or rectifications for flood control purposes, and to provide reimbursement of such projects constructed under the Flood Control Act of 1936. Secretary of War may either purchase the land and rights of way for dams and reservoirs or acquire them by condemnation; he may also pay entire cost of prior construction if he finds it reasonable.

Housing

Public No. 424 (H. R. 8730, Mr. Steagall of Alabama): To amend the National Housing Act, etc.

Adds a number of amendments to the National Housing Act of 1934, which liberalize the provisions for home modernization, improvement, and construction on rural, suburban, and urban property.

A Mutual Mortgage Insurance Fund is established, to be used by the Administrator as a revolving fund for carrying out the provisions of Title II of the Act. The aggregate amount of principal obligations of all mortgages insured which may be outstanding at one time is limited to $2,000,000,000, except that with the approval of the President, the aggregate amount may be increased to $3,000,000,000. New provisions are added having to do with Rental Housing Insurance, Intermediate Projects, and National Mortgage Associations.

International Highway

Public No. 564 (H. R. 8177, Mr. Magnuson of Washington): To create a commission to be known as the Alaskan International Highway Commission.

A five-member commission is set up, one of the members of which is to be a citizen of Alaska, and one a member of Congress. The commission is to cooperate with a similar body from the Dominion of Canada in a study having to do with the location and construction of a highway which it is proposed will connect the Pacific Northwest Section of the United States with British Columbia, the Yukon Territory, and Alaska. The commission is to make its report, with recommendations, to the President in two years.

Rivers and Harbors

Public No. 685 (H. R. 10298, Mr. Mansfield of Texas): Authorizing the construction, repair, and preservation of certain public works on rivers and harbors and for other purposes.

Fifty-three projects are included in the bill, the total estimated cost of which is $37,104,350, to be carried on under the supervision of the Chief of Engineers and the direction of the Secretary of War. The Act permits the Secretary of War to grant easements for rights of way for public roads and streets across lands acquired by the United States for river and harbor and flood control improvements, under certain restrictions.

The Secretary of War is given authority to continue hydrologic studies having to do with the route of the proposed Nicaragua Canal.

Emergency Relief Act, 1938

Public Res. 122 (H. J. Res. 679, Mr. Taylor of Colorado): Making appropriations for work relief, relief and otherwise to increase employment, by providing loans and grants for public works projects.

Act carries a total of $2,915,605,000 of which $2,703,605,000 are direct appropriations and

Forecast for September "Proceedings"

LATERAL EARTH AND CONCRETE PRESSURES

by Lazarus White and George Paaswell, Members Am. Soc. C.E.

A valuable set of theories drawn from experiences of the former Committee on Earths and Foundations.

TRANSPORTATION OF SAND AND GRAVEL IN A FOUR-INCH PIPE

by George W. Howard, Jun. Am. Soc. C.E.

A new approach to a complex hydraulic problem yields useful results, checked by tests at the U. S. Waterways Experiment Station at Vicksburg, Miss.

WIND FORCES ON A TALL BUILDING

by J. Charles Rathbun, M. Am. Soc. C.E.

Significant wind-load observations on the Empire State Building, with tentative conclusions designed to encourage discussion.

PRINCIPLES APPYING TO HIGHWAY ROADBEDS

by Ira B. Mullis

Discussing the mechanical properties of typical earthy formations with reference to their suitability for roadbed use.

$212,000,000 farm parity payments. In the Relief and Work Relief portion of the bill appropriations were made to Works Progress Administration, National Youth Administration, Farm Security Administration, Puerto Rico Reconstruction Administration, National Resources Committee, and miscellaneous grants bringing total under Title I to $1,712,905,000 plus current unexpended balances from the current fiscal year.

Public Works Administration is extended to June 30, 1941, and given an appropriation of $965,000,000, with certain restrictions as to its use.

Means are provided whereby the Federal Building Program, the Rural Electrification Administration and the U. S. Housing Authority may secure substantial additional funds.

Reconstruction Finance Corporation

Public No. 479 (S. 3735, Mr. Glass of Virginia): To amend Section 5(d) of the reconstruction Finance Corporation Act, etc.

For purpose of maintaining and promoting economic stability, encouraging employment of labor, the Reconstruction Finance Corporation, up to June 30, 1939, is authorized to make loans to or contracts with states, municipalities and public instrumentalities of one or more states to aid in financing projects authorized under federal or state laws. Corporation can also purchase securities and make loans to business enterprises whenever capital or credit at prevailing rates for character of loan required is not available, provided retirement of securities or repayment of loan is reasonably assured. Railroad loans of the kind requiring approval of Interstate Commerce Commission are not included within scope of this Act.

Boundary Waters

Public No. 456 (S. 1570, Mr. Frazier of North Dakota): Granting the consent of Congress to compacts or agreements between the states of Minnesota, South Dakota, and North Dakota with respect to the Red River of the North.

Deals with utilization and control of the waters of the Red River and its tributaries.

Interstate Streams

Public Resolution No. 94 (H. J. Res. 150, Mr. Clark of Idaho): To permit a compact or agreement between the states of Idaho and Wyoming, respecting the disposition of the waters of the Snake River, etc.

Forestry

S. Con. Res. 31 (Mr. McAdoo of California): A Joint Congressional Committee on Forestry is created, of five Senators and five members of the House, named by the presiding officers of their respective houses, with the chairman to be named by the committee.

Members of Joint Committee are Senators McAdoo, Smith (S.C.), Bankhead, Pope, and McNary; Representatives Fulmer, Doxey, Pierce, Reed, and Englebright.

Committee is directed to investigate the present and prospective situation with respect to forest land of the United States, its condition, ownership, and management as it affects a balanced timber budget, watershed protection and flood control, and other commodities and social and economic benefits to be derived from such lands. Committee to report by April 1, 1939, with recommendations for legislation. $10,000 authorized for expenses.

Natural Gas

Public No. 688 (H. R. 6586, Mr. Lea of California): To regulate the transportation and sale of natural gas in interstate commerce, etc.

Federal Power Commission given jurisdiction over transportation of natural gas in interstate commerce. Extent of Commission's powers described.

Construction Papers Available

ONE OF THE services performed by the Society and available to members and others, but particularly for the benefit of members, is the stocking of reprints of the various papers from TRANSACTIONS. These are in pamphlet form, suitably covered in heavy flexible paper, and offered for sale in individual copies.

Frequently members who have already received certain papers in their regular TRANSACTIONS desire an extra copy on a certain subject, on account of ease in handling, necessity of carrying on a journey, or for ready reference on a drawing table or desk. This form of reprint will also appeal to the newer members of the Society, those who have missed the earlier issues of TRANSACTIONS and wish to enlarge their library or reference list by purchase of individual papers rather than entire volumes of TRANSACTIONS.

With these needs in mind, a list has been prepared covering a special subject, selected for trial, to discover whether members are sufficiently interested in purchasing such reprints. The present list deals with the construction field and covers papers from the 1930–1937 volumes of TRANSACTIONS that appear to be of particular interest to members enrolled in the Construction Division. Other similar lists may be made available from time to time if interest warrants.

It should be noted that the prices given are those for general sale, and that in every instance a discount of 50 per cent is extended to members of the Society. Furthermore, a complete list of reprints from the TRANSACTIONS through Volume 102 (1937) is available in pamphlet form, upon request.

The present tabulation has been divided into 15 sub-topics, covering various branches in the general field of construction. It is hoped that the list will prove helpful in directing attention to a few of the many outstanding papers available as reprints.

Aqueducts

No. 1970	(1937)	Surface and Sub-Surface Investigations Quabbin Dams and Aqueduct. A symposium. By Frank E. Winsor, Stanley M. Dore, and Frank E. Fahlquist	$ .75

Contracts

No. 1724	(1930)	General Contract System Versus Segregated Contracts. By Ward P. Christie	.40
No. 1740	(1930)	Letting Construction Work by Competitive Bidding. By Edward W. Bush	.55
No. 1861	(1934)	Prequalification of Contractors. By C. J. Tilden	.20

Dams

No. 1863	(1934)	Foundation Treatment at Rodriguez Dam. By Charles P. Williams	.20
No. 1877*	(1934)	Actual Deflections and Temperatures in a Trial-Load Arch Dam. By A. T. Larned and W. S. Merrill	.70
No. 1937	(1936)	Stabilizing Constructed Masonry Dams by Means of Cement Injections. By D. W. Cole	.55
No. 1970	(1937)	Surface and Sub-Surface Investigations Quabbin Dams and Aqueduct. A symposium. By Frank E. Winsor, Stanley M. Dore, and Frank E. Fahlquist	.75

Foundations

No. 1863	(1934)	Foundation Treatment at Rodriguez Dam. By Charles P. Williams	.20
No. 1945	(1936)	Distribution of Stresses Under a Foundation. By A. E. Cummings	.65
No. 1959	(1937)	Lateral Pile-Loading Tests. By Lawrence B. Feagin	.55

Highways

No. 1830	(1933)	Highway Construction Management. By T. Warren Allen	.30
No. 1831	(1933)	Construction Management. By Richard Hopkins	.25
No. 1836	(1933)	Western Highway Practice, with Special Reference to California. By C. S. Pope	.45
No. 1893	(1935)	Lincoln Highway from Jersey City to Elizabeth, New Jersey. By Sigvald Johannesson	.30

Materials of Construction

No. 1751	(1930)	Measuring Materials for Concrete. By William Mayo Venable	.25
No. 1816	(1932)	Manufacturing Concrete of Uniform Quality. By William M. Hall	.45
No. 1838	(1933)	Effects of Bending Wire Rope. By Frederick C. Carstarphen	.60
No. 1888	(1934)	Deformation of Steel Reinforcement	

		During and After Construction. By Sergius I. Sergev	.35
No. 1968	(1937)	Behavior of Stationary Wire Ropes in Tension and Bending. By Douglas M. Stewart	.55
Pipe Lines			
No. 1795†	(1932)	Construction of La Ola Pipe Line in Chile. By W. B. Saunders	.45
No. 1802	(1932)	Economical Design of Hydraulic Pipe-Line Dredge. By John Francis Cushing	.45
Power Transmission			
No. 1846	(1933)	Design Characteristics of the Reading Overbuild Transmission Line. By Frederick W. Deck	.30
Pumps			
No. 1734	(1930)	Characteristics of Centrifugal Oil Pump. By Michael D. Aisenstein	.25
Retaining Walls			
No. 1908†	(1935)	Analysis of Sheet-Pile Bulkheads. By Paul Baumann	.95
No. 1913	(1935)	Wave Pressures on Sea-Walls and Breakwaters. By David A. Molitor	.40
Sewage Disposal			
No. 1738‡	(1930)	The Sewage Disposal Works of Decatur, Illinois. By Samuel A. Greeley and William D. Hatfield	.60
Structural Engineering			
No. 1768	(1931)	Construction of the James River Bridge Project. By R. C. Wilson and Herbert B. Pope	.25
No. 1787	(1931)	Final Report of the Committee of the Structural Division on Florida Hurricane	.20
No. 1839	(1933)	Lake Champlain Bridge. By Charles M. Spofford	.40
No. 1840	(1933)	Construction Plant and Methods for Erecting Steel Bridges. By A. F. Reichmann	.25
No. 1860‡	(1934)	The Martinez-Benicia Bridge. By W. H. Kirkbride	.40
No. 1864	(1934)	A History of the Development of Wooden Bridges. By Robert Fletcher and J. P. Snow	.95
No. 1876†	(1934)	Three-Span Continuous-Truss Railroad Bridge, Cincinnati, Ohio. By Wilson T. Ballard	.25
No. 1906	(1935)	Flexible "First-Story" Construction for Earthquake Resistance. By Norman R. Green	.30
No. 1922	(1935)	Final Report of the Special Committee on Concrete and Reinforced Concrete Arches	1.60
Tunnels			
No. 1771‡	(1931)	Completion of Moffat Tunnel of Colorado. By Clifford A. Betts	.45
No. 1809‖	(1932)	The Eight-Mile Cascade Tunnel, Great Northern Railway. A symposium	.90
No. 1841‡	(1933)	Fulton Street, East River Tunnels, New York, N.Y. By Miles I. Killmer	.35
Water Power			
No. 1775§	(1931)	The Shannon Power Development in the Irish Free State. By A. R. C Markl	.20
No. 1773	(1931)	Baldwin Filtration Plant, Cleveland, Ohio. By J. W. Ellms, G. W. Hamlin, A. G. Levy, and J. E. A. Linders	.75
No. 1806	(1932)	The Don Martin Project. By Andrew Weiss	.30
No. 1834	(1933)	Construction Work on a Federal Reclamation Project. By Morris Mason	.60
Waterways			
No. 1726*	(1930)	Flood Control on the River Po in Italy. By John R. Freeman	.65
No. 1777†	(1931)	The Chesapeake and Delaware Canal. By Earl I. Brown	.50
No. 1781	(1931)	The Training Wall Across the Liao Bar in Manchuria. By P. N. Fawcett	.30
No. 1833	(1933)	Engineering Features of the Illinois Waterway. By Walter M. Smith	.55
No. 1850	(1933)	Construction Methods on the Welland Ship Canal. By E. G. Cameron	.60
No. 1901§	(1935)	Renewal of Miter-Gate Bearings, Panama Canal. By Clinton Morse	.30

* J. James R. Croes Medal
† James Laurie Prize
‡ Thomas Fitch Rowland Prize
§ Collingwood Prize for Juniors
‖ Arthur M. Wellington Prize for Part 1 of this paper, and Thomas Fitch Rowland Prize for Part 3

Administering a Local Section

By E. L. WARNER, PRESIDENT OF THE TACOMA SECTION

Abstract of Address at the Conference of Western Local Sections, Salt Lake City, July 19, 1938

I AM not particularly interested, for the purpose of this discussion, in a member's education or qualifications or salary. The only thing I am interested in is that he belongs to the Society and that he is affiliated with the local group, and it is up to the Local Section administration to do something about it.

I would like to compare a Local Section to a college. It is a place where a group of people with varying and varied backgrounds, but more or less similar ambitions and aims, could get together and become acquainted, make friends, exchange ideas and information and influence. As engineers we gain the basis for our technical information and learn how to think along technical and engineering lines; we learn to think as well as to solve; and finally, more important than anything else, we learn that one small head cannot carry all the information there is available on a subject. And so we depart out into the world, as engineers, having learned where it is to be found in the books and how to interpret it. That is my picture of a college. It is also my picture of a Local Section.

In other words, if we can provide a place where engineers like to meet, where they enjoy the opportunity to associate with one another and to mingle and become acquainted and form friendships, exchange ideas and influences, and where the acquisition of new information through the medium of programs is available, then I think we have built a successful Section.

The meeting place should be the finest and nicest meeting place that is available, and the meal that is served (I believe there should be a meal) should be the most expensive that the large majority of the members can afford to buy. No Section can thrive in an atmosphere of the greasy-spoon variety.

The business of the Section should be handled by regular meetings of the board, and the matters should be so thoroughly threshed out there that when they are presented to the Section for final disposition a minimum of discussion is required.

I would lean to a minimum of committees if for no other reason than to get away from a multiplicity of reports. I think a thing can very easily be organized to death. Standard committees to cover the standard functions, of course, are important. Beyond that I would not go.

I have come to believe, over these few years of observation, that one good man is a better program committee than three, five, or a dozen, even if they are all good. He should have nerve enough to ask anybody to speak no matter how important or busy the man may be, and to suggest that the speaker should sit down when everybody but the speaker knows he is through. He should be conceited enough to consider himself an average member of the Section, so that he will be in a position to plan programs that should please the majority of the group.

The programs themselves I think should be varied. They should be inspected or checked over just as carefully for timeliness and general interest as they should be for technical content. The speakers, naturally, are very important. The only man who is entitled to appear on the program is the man who has a real message to give and the ability to present it. The program should afford a place for the Juniors and the students to expend their energies for their benefit as well as ours.

The feeling of congeniality and good fellowship is one of the things that runs a Section. If you go into a Section and you don't dare laugh out loud, it is a flop.

The Tacoma Section is largely made up of engineers from Tacoma; and from Olympia, the state capital, where the State Highway Department is. We have ten counties in southwest Washington and our fall meeting will be held down in the center of the Section rather than up in Tacoma in the northern part of our area. We will go down to Longview and invite the Portland Section up to meet with us. We will invite all the engineers in that area whether they are Society members or not to come in and look us over.

The Tacoma Section was organized some time in 1930 just prior to the Annual Convention there in 1931. At that time there was formed a ladies' auxiliary for the better entertainment of the wives in attendance at the convention. This ladies' group is still in existence. They have their own officers, they raise their own finances, they have their own meetings at times different from ours. Their function is mostly social, but they are still functioning and once a year at our annual installation our meeting takes the form of a dinner dance and our meal becomes more of a banquet. All but the very necessary items of business are dispensed with; the program becomes light, suitable entertainment; and the evening is given over to dancing. With all the things that have contributed to what we believe is a successful Section in Tacoma, the ladies have contributed a lot.

Publicizing Local Section Activities

How to Advise the Membership and to Inform the Public

By RALPH G. WADSWORTH, PRESIDENT OF THE SAN FRANCISCO SECTION

READ BY T. J. CORWIN, JR., SECRETARY OF THE SECTION, AT THE LOCAL SECTIONS CONFERENCE AT SALT LAKE CITY, JULY 19, 1938

FROM the standpoint of purpose or objective, there are two types of local publicity for a Section which, for the purpose of discussion, are here designated as inside publicity and outside publicity; that is, the first type is for the information of our own members, and the second for the information and education of persons outside the Section.

INFORMING THE MEMBERS

Inside publicity is essential to the success of a Local Section, particularly if the membership is scattered over a wide area. Possibly not more than 25 per cent of the membership of a Section attend any single meeting, and probably 50 per cent never attend a meeting in any given year. Consequently the meetings can hardly be expected to serve as a medium for keeping the entire membership informed as to the activities of the Section. The purpose of inside publicity is to keep all members fully acquainted with the activities of the officers, committees, and individual members of the Section with a view to stimulating attendance at meetings and sustaining interest. If these purposes can be accomplished, the Section is assured of increasing membership rolls and continuing income through the collection of local dues.

The methods of securing inside publicity are limited and comparatively simple. The obvious method is to issue at regular intervals some form of publication presenting all possible information which might be of interest to the whole membership. It would include the minutes of meetings, but this probably is not sufficient. During the past two years the San Francisco Section has been sending out, in addition to the regular monthly proceedings of the meetings, a three- or four-page publication containing items of general and personal interest, written up in informal style so as to attract attention. It would be very helpful if the several Sections that issue a news publication would exchange copies with one another.

INFORMING THE PUBLIC

Outside publicity is much more difficult, and, perhaps to the profession as a whole, is much more important. The purpose of outside publicity is to acquaint the general public with the activities of the Society, the Local Section, and the engineers who comprise its membership. It is important that the public in general have a better conception of the services that civil engineers can render. Every encouragement should be given to the idea that construction work should receive the attention of engineers at some time in the process of promotion, and prior to the actual expenditure of funds. The public should also be informed that the Society maintains standards of ethics and professional conduct and serves as a safeguard to the public against improper or incompetent work.

Several methods suggest themselves to bring about desirable outside publicity, and many of these have been discussed at previous Local Sections' conferences. The methods which have been suggested, and which we are attempting to employ in the San Francisco Section, are as follows:

1. Supply news items of interest to local newspapers and to various journals. A news bulletin, if used by a Section, may be of value as a means of transmitting news to newspapers, particularly newspapers in communities at a distance from the headquarters of the Section. This is true, of course, only if the news bulletin contains material of general interest not already published.
2. Publish articles or summaries of articles that have been presented at Local Section meetings, giving credit not only to the speaker but also to the Section under whose auspices the meeting was held.
3. Encourage members of the Section to serve on various civic committees where engineering training will be helpful.
4. Encourage requests from fraternal and civic organizations for speakers on engineering subjects and select members of the Section for such assignments.

All these methods should be in the hands of a publicity committee, which must be extremely aggressive and alert. The job is not an easy one. It requires continuous attention so that occurrences of consequence can be picked up and reported promptly.

The publicity committee should be continued from year to year without complete reorganization at the end of each term of the officers of the Section. This will permit of taking advantage of contacts made by members of the committee with reporters, editors, and others through whom news releases are secured. In a Section that has a paid secretary, it is probable that he should either act as the center for the release of news, or should at least work very actively with the publicity committee so as to insure uniform methods and policies.

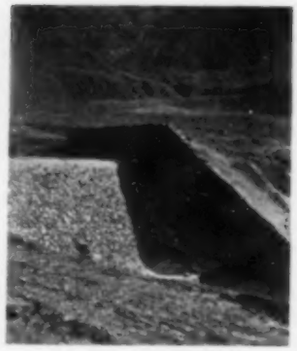
Society Members Inspect Garfield Flood Control Construction

MEMBERS of the Society attending the Annual Convention at Salt Lake City took particular interest in the million-dollar flood-control structures designed to protect the Garfield smelter of the American Smelting and Refining Corporation from disastrous mud flows from the steep canyon behind the plant. Rain storms of cloudburst intensity, even when covering comparatively small areas, bring down soil, gravel, and boulders in a mixture re-

INSPECTING EROSION-CONTROL DAM

sembling wet concrete and possessing a disastrous crushing power.

The structures now being built consist of two mile-long earth dams to create successive stilling pools in which the flood stream can deposit the greater part of its burden. The water itself is then to flow through spillways, channels, and intermediate drops to the lower basin and thence through a 20-ft square culvert beneath the plant buildings. For greatest protection from erosion, many of the hydraulic structures have a surface of one- or two-man stone set in a concrete backing. The texture of the resulting surface is shown in the accompanying photograph of an intermediate drop with a 30-ft wing wall. The other photograph shows the inspecting party listening to a description of the work before dispersing to examine the details of the project.



30-FT RETAINING WALL

News of Local Sections

Scheduled Meetings

DISTRICT OF COLUMBIA SECTION—Inspection trip to the U. S. Naval Model Basin on the Potomac River on September 17.

GEORGIA SECTION—Luncheon meeting at the Atlanta Athletic Club on September 12, at 12:30 p.m.

ILLINOIS SECTION—Luncheon meetings at the Chicago Engineers Club every Friday noon during September.

LOS ANGELES SECTION—Dinner meeting at the University Club on September 14, at 6:15 p.m.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday, at 12:10 p.m.

ST. LOUIS SECTION—Luncheon meeting at the Mayfair Hotel on September 26, at 12:15 p.m.

SEATTLE SECTION—Dinner meeting at the Engineers Club on September 26, at 6:00 p.m.

TENNESSEE VALLEY SECTION—Dinner meeting of the Asheville Sub-Section at the George Vanderbilt Hotel on September 19, at 6:30 p.m.; dinner meeting of the Chattanooga Sub-Section at the Y.W.C.A., on September 22, at 6:30 p.m.; dinner meeting of the Knoxville Sub-Section at the University Cafeteria on September 1, at 6:15 p.m.

TOLEDO SECTION—Dinner meeting during the first or second week in September (time and place to be determined later).

Recent Activities

ARIZONA SECTION

A dinner meeting of the Arizona Section took place at Phoenix on July 13. On this occasion the guest of honor and speaker was Raymond A. Hill, Director of the Society. There were 14 present.

DISTRICT OF COLUMBIA SECTION

On June 27 members of the Junior Forum of the District of Columbia Section enjoyed an interesting meeting. After a brief business discussion the session was turned over to James H. Carr, Jr., the speaker of the evening. Mr. Carr, who is connected with the National Lumber Manufacturers' Association, then presented an illustrated paper on "The Use of Lumber as a Structural Material." He is at present engaged in running some tests on timber construction in the engineering laboratory at George Washington University, and his comments proved of great interest.

HAWAII SECTION

There were 23 present at a meeting of the Hawaii Section, which took place at the Pacific Club in Honolulu on June 7. Following dinner and a short business meeting, an interesting technical discussion was led by William R. Bartels, bridge engineer in the Department of Public Works, Division of Highways. Mr. Bartels commented on factors in the design and construction of several types of bridges recently built in Hawaii, and answered many questions.

MICHIGAN SECTION

At the end of the current school year the Michigan State College Student Chapter was host to the Michigan Section at Lansing. Chester L. Allen, vice-president of the Section, acted as toastmaster, and there were speeches by both Section and Student Chapter officers. Because of the illness of Professor Hanna, the scheduled speaker, the technical program was in the hands of James Tyson, professor of soils at Michigan State College, who gave a very interesting talk. There were 42 present.

NORTHEASTERN SECTION

Despite a heavy rainfall, over 250 members of the Northeastern Section of the Society and the Boston Society of Civil Engineers enjoyed a joint outing on June 11 to the Quabbin Reservoir of the new Ware–Swift water supply of the Boston Metropolitan Water District. This all-day excursion included an inspection of the Ware River intake works at Barre, and the intake works, dam, and dike at the Quabbin Reservoir. Following luncheon, a brief explanation of the works was given by Karl R. Kennison, assistant chief engineer of the Metropolitan District Water Supply Commission and also president of the Boston Society of Civil Engineers. Others who discussed the project were Frank E. Winsor, chief engineer of the Commission, and Eugene C. Hultman, chairman of the Commission. It is expected that the filling of Quabbin Reservoir will begin in the spring of 1939.

PANAMA SECTION

A meeting of the Panama Section was held at the Union Club in Panama City on July 11. The speaker of the occasion was A. W. Brooks, superintendent of the northern district of the Municipal Engineering Division of the Panama Canal. Mr. Brooks gave a comprehensive description of the municipal water supply, and sewerage facilities of the Canal Zone and, later, led a general discussion on the subject. After a business session the meeting adjourned and refreshments were served. The attendance was 15.

PUERTO RICO SECTION

On July 15 a number of members of the Puerto Rico Section and representatives of the civic societies of the island attended a conference for the purpose of discussing the subject of federal legislation on housing and its effects in Puerto Rico. The discussion was led by Adriano Gonzalez, president of the Caribbean Engineering Company, who gave a thorough résumé of the situation. The public was invited to discuss various points, and it is felt that the conference took the first practical step in paving the way for helpful legislation in Puerto Rico.

SACRAMENTO SECTION

The usual luncheon meetings were enjoyed by the members of the Sacramento Section during July. At the meeting held on the 5th there were 57 present to hear Glenn Chamberlain, of the California Division of Highways, read a paper on "Concrete Mixes and Their Uses." An enthusiastic discussion followed. On July 12 Joseph C. Boyd, civil engineer of Sacramento, gave an illustrated lecture on a recent trip to Europe. The attendance was 56. The speakers at the luncheon held on July 19 were Mrs. Rita Campbell, supervisor of the branch libraries of Sacramento, who discussed a library bond issue soon to be voted on; and C. F. Hamlin who spoke on the projects of the Tennessee Valley Authority, where he was employed for some time. On July 26 George D. Gilbert, junior engineering field aid in the California State Division of Highways, gave an interesting talk on reporting and accounting of railroad work on federal grade separations.

SPOKANE SECTION

Following a luncheon held at the Crescent Tea Room on July 8, members of the Spokane Section discussed various business matters. Several committees were appointed, and John Howard was selected as the official delegate to represent the Section at the Salt Lake City Meeting. There were 14 present.

TEXAS SECTION

New officers for the Fort Worth Branch of the Texas Section were recently elected. These are William Grant, president, and Marvin C. Nichols, vice-president. Homer Hunter was reelected secretary-treasurer.

ITEMS OF INTEREST

Engineering Events in Brief

CIVIL ENGINEERING for October

NEXT month's CIVIL ENGINEERING will carry the second of Clarence W. Hubbell's informative articles on the Detroit sewage disposal project. The earlier paper, published in July, gave the background, development, and a brief general description of the project; the forthcoming installment includes a detailed description of the plant itself. Plain sedimentation, sludge incineration, and chlorination of the effluent are the treatment processes for which provision is being made.

Another interesting feature of the October issue is E. K. Morse's historical account of the errors made in the construction of the Hawkesbury Bridge in Australia some 50 years ago. It was Mr. Morse's first field assignment, and the difficulties he encountered in floating the heavy steel spans into place and in other features of the work make a fascinating story that is not without a moral.

Of special value to Juniors will be Alton C. Chick's paper describing the "Rhode Island Experiment"—the junior engineers' organization for professional development that has attracted attention throughout the country. How it was started, how it is being carried on, its aims and activities, are all explained in detail.

Other papers on the schedule are being chosen from the fields of airway and highway transportation, erosion control, irrigation, water supply, and surveying. Some of these are abridgments of papers presented at the Annual Convention, while others are independent contributions.

American Welding Society Issues Handbook

IN RESPONSE to a demand for practical up-to-date information on the subject, the American Welding Society has just published the first edition of its *Welding Handbook*, a comprehensive 1,200-page volume treating all phases of the art. The contents fall into four main sections. The first covers the fundamentals of the various processes (arc, gas, resistance, and thermit welding; stress-relieving; and so forth); the second, materials and metallurgy; the third, testing; and the fourth, applications. Full data on metal cutting and a number of processes allied to welding and cutting are also given. In the last section, the chapters on design and fabrication of buildings, bridges, and railway rolling stock and track are of special interest to civil engineers.

More than a year and a half was devoted to the preparation of this volume, which was kept up to date until the last possible moment. An impartial approach to the subject matter characterizes the whole treatment. To ensure accuracy of statement and authoritative recommendations, the editorial committee selected outstanding authorities in each field as authors for the respective chapters, and later invited a number of other authorities to review each chapter. Thus 90 authors and 237 reviewers participated in the preparation of the book. D. S. Jacobus was chairman of the editorial committee in charge of this work, and W. Spraragen was editor.

Copies of the handbook can be obtained from the American Welding Society, 33 West 39th Street, New York, N.Y., at $5 each to members of the American Welding Society, $6 to others in the United States, and $6.50 in foreign countries.

Society Representatives at International Engineering Congress, Glasgow

AS THE Society's representatives, W. J. Buchanan, of Glasgow, Scotland, and George A. Orrok, of New York, attended the International Engineering Congress held at Glasgow on June 21–24, 1938, in connection with the Empire Exhibition. More than one thousand persons were enroled in the congress, including official delegates from twenty different countries.

Among the papers presented at the technical sessions was one by Mr. Orrok, on "The Central Station in One Man's Lifetime." "This address proved most interesting," writes Mr. Buchanan, "and its value was greatly enhanced by the slides of American power stations that accompanied it. Mr. Orrok's keen sense of humor added greatly to the charm of the presentation." The program also included papers on such subjects as progress in the internal combustion engine; international air transport; and river and harbor developments at Glasgow. Receptions, and trips to cover the main industries and beauty spots of southern Scotland, were other features of interest.

The presidential address, by Lord Weir, "dealt with the progress of engineering throughout the world, and ended on a somewhat gloomy note, with a special reference to the debasement of science for the purposes of war." Mr. Buchanan concludes his report, however, in a more cheerful vein:

"The constituent units of this great congress appeared to blend admirably together to form a homogeneous body, irrespective of nationality, political opinion, or age, and it will certainly do much to extend that feeling of good will and comradeship now existing between the engineering societies of the world."

More Members Honored

IN THE July and August numbers of CIVIL ENGINEERING appeared lists of members who were awarded honorary degrees during the past commencement season. Since these issues went to press news of other members thus honored has been received at Society Headquarters. These are as follows:

ALEX DOW, Hon. M. Am. Soc. C.E., doctor of arts in business administration, Wayne University.

CHARLES H. LOCHER, M. Am. Soc. C.E., doctor of engineering, University of Maryland.

Page of Special Interest

THE picture reproduced on the page of special interest (page 5) of this issue was taken in Chicago, and shows Wrigley Tower, Michigan Drive, the Chicago River, and Wacker Drive. Because of the early hour, 7:20 a.m. (6:20 sun time), and the fact that it was Sunday, there are few people or automobiles on the street. The drives, bridges, and buildings are effectively framed by the buildings close to the camera, and blend to make an artistic study of what the engineer has done to help make a city great and attractive.

This photograph was taken from a window of the Medinah Club by Prof. Frank Kerekes, M. Am. Soc. C.E., of Iowa State College, while he was attending the Mid-Western Conference of Student Chapters.

Brief Notes from Here and There

Employment and the Engineer's Relation to It is the title of a 44-page booklet just published by American Engineering Council. Its contents comprise the addresses and digests of the discussions presented at Council's public forum held in Phila-

FALL MEETING of the Society, in Rochester, N.Y., October 12–15, 1938

delphia in May. Copies are available at 15 cents each at Council's headquarters, 744 Jackson Place, Washington, D.C.

* * * *

SANITARY engineers and water-works operators and chemists will gather in Boston on September 13–16 for the 57th Annual Convention of the New England Water Works Association. Features of the technical sessions are symposiums on the cost of a water supply in New England and on miscellaneous uses of water.

* * * *

A COMPREHENSIVE report on the Rio Grande joint investigation has just been published by the National Resources Committee as Part VI of its series on Regional Planning. The investigation, it is said, constitutes a unique approach to the problems underlying a grave controversy over an interstate river. "For the first time the states engaged in such a controversy joined with one another and with the federal government in an endeavor to find a satisfactory basis for the allocation of the waters of a river through the assembly of the factual data essential to such an allocation." The report includes sections on ground-water resources, water utilization, water quality, and water importation and storage. (Two volumes: Vol. I, Text, 566 pp.); Vol. II, Maps. For sale by the Superintendent of Documents, Washington, D.C., at $3.50 a set.)

* * * *

THE American Public Health Association will convene in Kansas City, Mo., on October 25, for its four-day annual meeting. The public health engineering section of the Association has arranged for a number of sessions of interest to sanitary engineers. Full details appear in the August issue of the *American Journal of Public Health*.

* * * *

MUNICIPALLY owned water works serve 83.6 per cent of the urban population of the United States, according to a recent survey of water works ownership in cities of 3,000 and over. In 22 states the percentage is above 90, and in only 5 is it less than 50.

* * * *

MANY important developments in welding will be discussed at the annual meeting of the American Welding Society, to be held in Detroit, October 16–21. Of special interest to civil engineers will be the technical session on welding in construction work (October 17); the "railroad session" (October 21); and a number of the papers to be presented at other sessions on such topics as aluminum, copper, and alloy welding; fatigue of welded connections; and the effect of rigid beam-column connections on column stresses.

* * * *

CIVIL ENGINEERS studying economic trends in large cities, the causes and effects of WPA, and direct and indirect relief in densely populated areas, will find of interest a relief study made recently by Howard Whipple Green, M. Am. Soc. C.E., under the auspices of the Cleveland Health Council. The study, "Two Hundred Millions for Relief in Cleveland, 1928–1938," traces the increase in appropriations for relief according to cost, scope, and the geographic distribution of needy persons. Like previous studies prepared by Mr. Green, this publication approaches economic problems by use of census tracts. The city of Cleveland and its suburbs are represented by 28 maps, dividing the city into economic areas showing such analyses as the number of jobless per 100 gainful workers, and the areas cared for by various beneficent organizations. Copies can be obtained from the Cleveland Health Council, 1001 Huron Road, Cleveland, at $1.00 each.

* * * *

BRITISH engineers are planning an extensive tour of Canada and the United States on the occasion of the joint autumn meeting of the Iron and Steel Institute and the Institute of Metals. They will arrive in New York on October 2, and in the following three weeks will visit Baltimore, Washington, Pittsburgh, Youngstown, Cleveland, Detroit, and Chicago. Their hosts in the United States will be the American Iron and Steel Institute and the American Institute of Mining and Metallurgical Engineers.

* * * *

SANTIAGO, Chile, will be host to the Third Pan-American Highway Congress in January 1939. In connection therewith an international highway exhibition is planned, at which road machinery, materials, and vehicles from many countries will be on display. Roberto Torretti of Santiago is commissioner general of the exhibition.

De Havilland's Arch

Collapse of the famous "De Havilland Arch" at Seringapatam, Mysore, India, was brought to the attention of "Civil Engineering" recently through the inquiry of a subscriber. The following details have just been secured from G. B. E. Truscott, Assoc. M. Am. Soc. C.E., and N. N. Ayyangar, chief engineer of Mysore.

FOR MANY YEARS the old brick arch at Seringapatam, India, was a point of interest to tourists. On first sight, it attracted attention by its lack of any apparent reason for existence, for its spanned a perfectly level piece of ground. Of interest also was its "springiness"; thousands of travelers, it is said, have amused themselves by jumping up and down on the keystone and watching the arch give and rebound.

This arch is of special historical interest to civil engineers. About 1806 De Havilland, the well-known British officer who later served as chief engineer of Madras, proposed bridging the river Cauvery with a series of brick arches of spans greatly exceeding any that had been attempted up to that time. When higher authority set his design aside as visionary, he resolved to demonstrate its practicability by building an experimental span in his own garden. The "Rainbow Bridge"—span 112 ft, rise 12 ft, width 3 ft—resulted.

The abutments were of rough stone in clay filled with earth, and were apparently

THE BRICK ARCH AT SERINGAPATAM, MYSORE

constructed in stages. The arch itself was of burnt country brick, in mortar, with a thickness of 3 ft 10½ in. at the crown and about 4 ft 6 in. at the springing. Stresses due to dead load amounted to about 9 tons per sq ft near the keystone and 12 tons per sq ft at the haunch—and the impact loads contributed by athletically inclined visitors probably added considerably to those figures.

No one knows just why the bridge collapsed in 1926 at the ripe old age of 130 years. Various theories have been put forward, such as the sliding action at the springing and the crushing of masonry. The collapse occurred during a heavy rain, when the arch was thoroughly soaked and therefore somewhat soft. "One is inclined to conclude," writes Mr. Ayyangar, "that failure was due to the heavy internal stresses and the deterioration of the arch with age." At all events, the collapse discredited a tradition that had developed among the people of the vicinity that the span contained some mysteriously designed inner reinforcement of metal. Nothing but brick and mortar was found in the ruins.

NEWS OF ENGINEERS

Personal Items About Society Members

ALBERT W. DOOLITTLE, JR., formerly a detailer for the American Bridge Company at Ambridge, Pa., is now draftsman and designer for Jackson, Moreland, Engineers, of Boston, Mass.

R. G. HOSEA recently resigned from the position of associate engineer for the International Boundary Commission, at El Paso, Tex., to accept that of engineer-secretary of the newly organized Colorado River Board of California, with offices in Los Angeles, Calif.

EDWARD L. MORELAND, for the past three years head of the department of electrical engineering at Massachusetts Institute of Technology, has been made dean of engineering there.

WALTER V. BARRY, city engineer of New Haven, Conn., has been appointed to the additional post of director of public works and will combine the duties of the two positions.

ROBERT H. RANDALL, consulting engineer for the National Resources Committee, Washington, D.C., was appointed by President Roosevelt to represent the United States at the first preparatory meeting of the International Public Works Committee at Geneva, Switzerland, which began on June 27.

WILLARD T. CHEVALIER, vice-president and publisher of the construction and mining papers of the McGraw-Hill Publishing Company, has accepted an appointment as publisher of *Business Week*.

LESLIE G. HOLLERAN has resigned as chief of the planning section of the WPA for New York City to become connected with the Metropolitan Life Insurance Company on work on its new housing development in New York City.

JAMES BERTRAND WELLS was recently notified of his appointment as professor of civil engineering at Stanford University. He was formerly associate professor of civil engineering.

J. S. RAFFETY, sanitary engineer for Hamilton County, Ohio, has been appointed manager of Laurel Homes, a Cincinnati housing project.

HOWARD L. WHITE has resigned from the engineering staff of the Indiana State Highway Commission to accept a position as instructor in the department of civil engineering at Rose Polytechnic Institute.

WILLIAM R. SEEGER is now employed as a sanitary engineer by C. C. Kennedy, consulting engineer of San Francisco.

IRVING V. A. HUIE, formerly consulting engineer for Madigan-Hyland, of New York City, has been made chief engineer and acting deputy commissioner of the Department of Public Works of the City of New York.

FRANK MILNER has been commissioned a second lieutenant in the Corps of Engineers, Regular Army, and ordered to duty with the Fifth Engineers, Fort Belvoir, Va.

MILTON E. CROSBY, until recently manager of the Chicago office of the Nicholson Company, has accepted a position as general manager of the Burrell Engineering and Construction Company, of Chicago.

M. J. POPPER is now employed as assistant designer for the New York City Board of Water Supply. He previously held a similar position with the New York City Tunnel Authority.

W. W. KELLY has assumed the position of general purchasing agent of the Atchison, Topeka and Santa Fe Railway Company, with headquarters in Chicago.

WARREN E. WILSON, formerly assistant professor of civil engineering at the South Dakota School of Mines, has accepted a similar position at Tulane University.

J. L. BARRON recently resigned as director of the division of sanitation of the Westchester County (New York) Department of Health to become county sanitary engineer and to organize a division of sanitation for the department of health in Nassau County.

HARRY E. SKINNER, previously in the U. S. Engineer Office at Rock Island, Ill., has been commissioned a second lieutenant in the Corps of Engineers, U. S. Army, at Fort Belvoir, Va.

ALFRED M. LUND has become connected with the Lund-Buxton Engineering Company in Little Rock, Ark. Until recently Mr. Lund was chief resident engineer-inspector for the PWA, with headquarters in the same city.

CHILTON A. WRIGHT, formerly hydraulic engineer for the National Hydraulic Laboratory, National Bureau of Standards, Washington, D.C., has been appointed professor of sanitary and hydraulic engineering at the Polytechnic Institute of Brooklyn.

C. W. ULLOM has resigned as assistant chief engineer of the Muskingum Watershed Conservancy District to accept a position as division engineer in the flood control bureau of the Water and Power Resources Board, Commonwealth of Pennsylvania, with headquarters in Harrisburg, Pa.

E. MONTFORD FUCIK is now employed as soil technician for the Harza Engineering Company, in connection with the Santee-Cooper Project at Charleston, S.C. He was formerly in the U. S. Engineer Office at Ithaca, N.Y.

CHARLES G. W. CALDWELL has accepted a position as district sanitarian for the 7th Health District at Silver City, N.Mex.

CARL H. HEILBRON, JR., previously assistant engineer for the Metropolitan Water District of Southern California, has become an associate engineer in the U. S. Engineer Office in Los Angeles, Calif.

CHARLES P. REMING has resigned as valuation engineer for the Railroad Commission of Texas to go into the office of the J. W. Beretta Engineers in the National Bank of Commerce Building, San Antonio, Tex.

CARL H. HOVEM, formerly area engineer for the WPA at Towner, N.Dak., is at present employed as principal civil engineering draftsman in the dam design section of the U. S. Engineers at Alhambra, Calif.

WILLIAM H. ROBERTS has been made commissioner of public works of Rochester, N.Y. He was formerly assistant engineer in the department of engineering of that city.

EDWARD C. LA VALLEY, for a number of years on the engineering faculty of New York University, has been appointed sanitary engineer in the division of sanitation of the Westchester County Department of Health.

WILLIAM H. SAYLOR is now an assistant engineer in the U. S. Engineer Office at Los Angeles, Calif. He was previously a junior engineer for the Metropolitan Water District of Southern California.

SIDNEY M. MARKS, formerly civil engineer for the Rosoff-Brader Construction Corporation, of New York City, has become an engineering inspector for the New York City Board of Water Supply, his present assignment being Shaft No. 17 at Valhalla, N.Y.

CLARENCE W. DUNHAM, assistant engineer in the design division of the Port of New York Authority, has been appointed instructor in architectural construction in the Cooper Union Art School, the appointment to be effective at the beginning of the current school year. Mr. Dunham will also continue his work with the Port of New York Authority.

JOHN J. HURLEY is now chairman of the Planning Board of the City of Somerville, Mass.

WILLIAM H. OVERSHINER, until recently with the Orange County (California) Flood Control District at Santa Ana, Calif., has become assistant engineer in the U. S. Engineer Office at that place.

HAL H. HALE has accepted a position as district office engineer of the southeastern district of the Portland Cement Association, with headquarters in the Hurt Building, Atlanta, Ga. For a number of years Mr. Hale was city engineer of Knoxville, Tenn., and he served as secretary-treasurer of the Tennessee Valley Section from the time of its organization in 1934 until his recent removal to Atlanta.

PERRY B. HACKETT was recently commissioned a second lieutenant in the Corps of Engineers, U. S. Army, and will be with the 3d Engineers, Schofield Barracks, Honolulu, Hawaii.

BENJAMIN C. SEAL, senior civil engineering draftsman for Hubbell, Roth and Clark, of Detroit, Mich., has been loaned by that organization to the W. E. Wood Company, for whom he will serve on the Down River Sewage Treatment Project.

BENJAMIN S. PHILBRICK has been appointed construction superintendent for the Tennessee Valley Authority at Guntersville Dam, Ala. He was formerly assistant construction superintendent on that project.

ROBERT E. HILES, until recently structural designer for the Alabama State Highway Commission at Montgomery, Ala., has accepted a position as assistant structural engineer in the U. S. Bureau of Yards and Docks in Washington, D.C.

HARRY T. POE, JR., is now senior engineer for the Santee-Cooper Power and Navigation Project, with headquarters in Charleston, S.C.

ERVIN GREENBAUM, formerly construction engineer for Rosoff Brothers, Inc., of Detroit, Mich., has become an engineer with the Michigan Public Works Commission, with headquarters in Lansing, Mich.

E. C. MACY has accepted a connection with Ulen and Company, of New York City. He was formerly with United Engineers and Constructors, Inc., in Philadelphia, Pa.

JACOB L. CRANE, JR., consulting engineer and city planner, has been appointed director of project planning, with headquarters in Washington, D.C.

ROBERT E. THOMAS, commander, C.E.C., U. S. Navy, has been appointed public works officer at the Puget Sound Navy Yard, effective October 1. He will succeed CAPT. E. R. GAYLER, who is retiring from the service.

KNOWLES K. MADISON, previously an engineer for the Commonwealth and Southern Corporation at Jackson, Mich., is now on the staff of Pate and Hirn, of Detroit.

DECEASED

LOUIS ANDREW BURNS (Assoc. M. '09) secretary of Burns Brothers and Haley, Inc., of Watertown, N.Y., died in that city on July 14, 1938. Mr. Burns, who was 59, was born in Watertown. For seven years he was assistant engineer on the construction of the New York State Barge Canal, and later served as resident engineer on the maintenance of this project. In 1919 Mr. Burns became a member of the contracting firm, Burns Brothers and Haley, Inc. In 1923 he was made secretary.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

FRANK RAYMOND COATES (Assoc. M. '00) died at Avon, N.J., on June 26, 1938, at the age of 69. After early experience in railroad engineering, Mr. Coates was with the Stone and Webster Engineering Corporation and the Inter Ocean Steel Company. From 1911 to 1921 he was president and general manager of the Toledo Railways and Light Company, and in the latter year he became president of the Toledo Edison Company. For a number of years prior to his death Mr. Coates was with Henry L. Doherty and Company, of New York City.

JOSEPH JAMES CORTI (Assoc. M. '96) civil engineer of Mendoza, Argentine Republic, died on June 17, 1938, at the age of 77. Mr. Corti played a prominent part in the engineering development of his country. His numerous activities included the introduction of reinforced concrete structures and macadam roads into his province, construction of the first astronomical observatory in Mendoza, and construction of the trans-Andean tunnel connecting the Argentine and Brazil.

BERNARD LABROQUERE CROZIER (M. '26) chief engineer of Baltimore, Md., died in that city on July 23, 1938, at the age of 48. Mr. Crozier joined the engineering staff of the Baltimore Paving Commission in 1912 and had been an employee of the city practically ever since. In 1931 he was appointed chief engineer and, as such, supervised all engineering, construction, and allied divisions of the city government. He was also a member of the Board of Estimates and of the public improvement commission.

JOHN LESLIE DOBBINS (Assoc. M. '12) consulting engineer of San Francisco, Calif., died on July 25, 1938, at the age of 54. Mr. Dobbins spent a number of years in China—from 1909 to 1916 as professor of railway engineering and, later, as head of the engineering department at Pei Yang University, Tientsin, and from 1916 to 1917 as vice-president and general manager of the American Machinery and Export Company, in Tientsin. Later Mr. Dobbins was connected with several engineering firms in the United States, and from 1921 until his death he maintained his own consulting practice.

JOHN HENRY GRAY (M.'95) died at his home in Orange, N.J., on August 5, 1938, at the age of 74. Until his retirement in 1917 Mr. Gray maintained offices in New York City, where for many years he specialized in structural steel work. He was a steel contractor on the construction of many large buildings in New York and other cities. Mr. Gray also did steel work for the Chicago World's Fair in 1893. About that time he invented and patented the "Gray Column," a device for installing water, plumbing, and electrical facilities in high buildings, which is widely used in skyscraper construction.

JOHN HOWELL GRIFFITH (M. '13) for many years associate professor of theoretical and applied mechanics at Iowa State College, died on July 14, 1938, at the age of 69. Mr. Griffith's early career included three years as professor of civil engineering at the Clarkson School of Technology and four years as assistant professor at the University of Michigan. Later he designed and superintended the construction of physical testing laboratories for the U. S. Bureau of Standards. In 1923 he joined the engineering staff at Iowa State College.

EDWARD LOVERING INGRAM (M. '25) professor of railroad engineering and geodesy at the University of Pennsylvania from 1911 until his retirement in 1932, died at his home at Nyack, N.Y., on July 25, 1938. Professor Ingram, who was 75, was born in Philadelphia, Pa. His early career included six years in the U. S. War Department and four years with the International Boundary Commission. From 1901 to 1906 he was an expert civil engineering aide for the U. S. Navy at the New York Navy Yard, and in 1906 he joined the staff of the University of Pennsylvania.

FREDERICK HORACE TIBBETTS (M. '17) civil engineer of San Francisco, Calif., died on August 3, 1938. He was 56. In 1909, after several years of varied experience, Mr. Tibbetts became a member of the civil engineering firm of Haviland and Tibbetts, in general charge of the San Francisco office. From 1917 on he maintained his own consulting practice, serving as chief engineer or consultant on many water supply, sewerage, and drainage projects in the West.

CHARLES COURTLANDT WHITAKER (M. '24) consulting engineer of Atlanta, Ga., died on August 3, 1938, at the age of 60. A specialist in steel and concrete construction, Mr. Whitaker was with the Truscon Steel Company from 1909 to 1923—most of the time as Southern representative in charge of the Atlanta sales office. From the latter year on he maintained his private practice in Atlanta, preparing plans for and supervising the construction of many buildings in Georgia and Florida.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From July 10 to August 9, 1938, Inclusive

Additions to Membership

BARCLAY, LELAND (Assoc. M. '38), Asst. Prof., Civ. Eng., Univ. of Texas (Res., 4414 Duval St.), Austin, Tex.

BARTZ, RICHARD HERMAN, JR. (Jun. '38), Draftsman, Frank F. Fowle & Co., 35 East Wacker Drive (Res., 8533 South Wood St.), Chicago, Ill.

BILUND, ALEX (Jun. '37), Structural Steel Detailer, Bethlehem Steel Co., South San Francisco (Res., 168 Cypress St., San Bruno), Calif.

BINGHAM, WILLIAM FREDERIC (Assoc. M. '38), Associate Engr., U. S. Bureau of Reclamation (Res., 25 East 16th Ave.), Denver, Colo.

BULL, CHARLES BEEKMAN (Assoc. M. '38), Field Engr., Asst. Chf. of Planning, WPA Sewers (Res., 1165 Fifth Ave.), New York, N.Y.

BUMSTEAD, JOHN CHAMBERS (Jun. '38), Asst. Engr., S. J. Mott, 368 Broadway, (Res., 4 Madison Ave.), Saratoga Springs, N.Y.

BUNKER, WILLIAM BEEHLER (Jun. '38), Lieut., Corps of Engrs., U.S.A.; Asst. to Area Engr., U. S. Engr. Office, 31 St. James Ave., Boston, Mass.

CASEY, THOMAS BERNARD (M. '38), 6530 Glenwood Ave., Chicago, Ill.

CHESTON, JAMES HUNTER (Assoc. M. '37), Senior Specifications Engr., TVA, 609 Arnstein Bldg., Knoxville, Tenn.

CUTLER, THOMAS HENRY (M. '38), State Highway Engr., Commonwealth of Kentucky (Res., 509 Shelby St.), Frankfort, Ky.

DUNN, CLARK ALLAN (Assoc. M. '38), Associate Prof., Civ. Eng., Oklahoma Agri. and Mech. Coll., Stillwater, Okla.

ETHRIDGE, FLAVEL DRYDEN, JR. (Jun. '38), Dist. Supervisor of Malaria Control, U. S. Public Health Service, Jackson, Miss.

FENNO, CHARLES ANTHONY, JR. (Jun. '38), Junior Engr., U. S. Govt., War Dept., U. S. Engr. Office (Res., 1219 Fifth Ave.), Huntington, W.Va.

FRAME, STANLEY HOWARD (Assoc. M. '38), Hydr. Engr., Dept. of Lands, Water Rights Branch, Parliament Bldgs., Victoria, B.C., Canada.

GARDNER, ROY LAWRENCE (Jun. '38), Teaching Fellow, Coll. of Eng., Univ. of Washington (Res., 1607 Seventh Ave., West), Seattle, Wash.

GARNETT, RAYMOND RAITHEL (Jun. '38), Care, U. S. Engr. Office, 751 South Figueroa St., Los Angeles, Calif.

GEORGE, HENRY HORTENSIUS, 3d (M. '38), Asst. Engr., in Chg. of Services, Dept. of Public Works, City of Norfolk, Box 464, Norfolk, Va.

GOODRICH, JOHN EMERY (Assoc. M. '38), Senior Engr. with U. S. Div. Engr., Box U, Plaza Station, St. Louis, Mo.

GOULD, JOHN MELVIN (Assoc. M. '38), Res. Engr., Pacific Gas & Elec. Co., San Francisco (Res., 330 San Carlos Ave., Piedmont), Calif.

HARTSFIELD, MARVIN FURR (Jun. '38), Box 141, Oxford, Miss.

HEBERT, GREGORY MACDONALD (Jun. '38), 1312 South Elgin, Tulsa, Okla.

HUTCHINGS, JOHN BACON, JR. (M. '38), With Charles E. Waddell, 229 Arcade Bldg., Asheville, N.C.

KNOWLES, BURT LE ROY (M. '38), Field Engr., The Associated Gen. Contrs. of America, Inc., Room 1227 Munsey Bldg., Washington, D.C. (Res., 6 Algonquin Rd., Worcester, Mass.)

KUSSMAUL, TAYLOR CHRISTIAN (M. '38), San. Engr. (Burgess & Niple), 568 East Broad St., Columbus, Ohio.

LANE, AARON JOSEPH (Jun. '38), Box 105, Jewell City, Kans.

LEGGET, ROBERT FERGUSON (Assoc. M. '38), Asst. Prof., Dept. of Civ. Eng., The Univ. of, Toronto, Toronto, Ontario, Canada.

LEVY, WALTER JOSEPH (Assoc. M. '38), Estimator and Engr., G. Walter Tovell, Inc. (Res. 4010 Carlisle Ave.), Baltimore, Md.

MCFADDEN, JAMES ALEXANDER (Assoc. M. '38), Asst. Structural Engr., TVA, Box 380, Norris, Tenn.

MANNEL, CHARLES (M. '38), Asst. Engr., Chas. E. Waddell, Box 525, Asheville, N.C.

MAXTON, HOWARD PRESTON (Assoc. M. '38), Gen. Cost Engr., TVA, Norris, Tenn.

MAY, JOSEPH OTTO (M. '38), Engr. in Chg. of Estimating and Designing, Am. Bridge Co., 71 Broadway, New York, N.Y. (Res., 137 Hope St., Ridgewood, N.J.)

MORRIS, ROBERT MAXWELL, JR. (Jun. '38), Junior Engr., U. S. Engr. Office (Res., 702 Maryland Ave.), Pittsburgh, Pa.

MUNGER, ELMER LEWIS (Jun. '38), Rodman, St. L. S. W. Ry. (Res., 1602 West 6th Ave.), Pine Bluff, Ark.

MYERS, COLBY MAXWELL (Assoc. M. '38), Capt., Corps. of Engrs., U.S.A., The Command and General Staff School, Fort Leavenworth, Kans.

NASVIK, PETER OLIVER (Jun. '38), Supt., the Nasvik Constr. Co. (Res., 1368 Ashland Ave.), St. Paul, Minn.

NORMAN, CLYDE THOMAS (Jun. '37), 1214 Cascade, Dallas, Tex.

ODELL, JOHN WESLEY (M. '38), Div. Engr., Great Lakes Dredge & Dock Co., 1100 Morgan Bldg., Buffalo, N.Y.

RALSTON, GERALD EDWARD (Jun. '38), City Engr. (Res., 1207 West Pleasant St.), Freeport, Ill.

REECE, KEMP WILSON (Assoc. M. '38), Asst. Engr., Phoenix Eng. Corporation, 2 Rector St., New York (Res., 1428 Midland Ave., Bronxville), N.Y.

RICE, EDWARD BURNS (Assoc. M. '38), Care, U. S. Geological Survey, Box 2052, Jackson, Miss.

ROBINSON, DONALD STEPHEN (Jun. '38), 3355 Balmoral Ave., Chicago, Ill.

SCHRODER, FREDERICK EDWARD (M. '38), Pres., F. E. Schroder, Inc., Great Notch (Res., 4 Craig Pl., Cranford), N.J.

SHAFER, IRVEN CLARENCE (Assoc. M. '38), Bridge Insp., State Highway Comm., 2059 Buchanan St., Topeka, Kans.

SMIRNOFF, MICHAEL VIACHESLAV (Assoc. M. '38), Designing Draftsman, Dept. of Design, Bureau of Streets and Sewers, City of Pittsburgh (Res., 5717 Center Ave.), Pittsburgh, Pa.

SOLNAR, GEORGE EDWIN, JR. (Jun. '38), 1231 R St., Fresno, Calif.

SPALDING, LAWRENCE (M. '38), Chairman, Valuation Committee, U. S. Steel Corporation; Valuation Engr., Union R.R.; Valuation Engr., B. & L.E.R.R. (Res., 310 Clinton St.), Greenville, Pa.

T'ANG, CHEN-HSU (Jun. '38), Cosmopolitan Club, Ithaca, N.Y.

THOMAS, RALPH G. (Assoc. M. '38), Dist. Engr., Dept. of Building (Res., 424 East 92d St.), Los Angeles, Calif.

TOWNER, JAMES MADSEN (Jun. '38), 2016 Wheeler, Houston, Tex.

VAN WAGONER, MURRAY DELOS (M. '38), State Highway Commr. (Res., 446 Everett St.), Lansing, Mich.

VOUGHT, HARRY (Assoc. M. '38), Associate Engr., WPA, 70 Columbus Ave., New York (Res., 91-14 One Hundred and Eighty-Second Pl., Jamaica), N.Y.

WARREN, FRANK MANLEY, JR. (Jun. '38), Statistical Engr., Portland Gen. Elec. Co., 509 Electric Bldg., Portland, Ore.

WHITAKER, ROBERT LYNN (Assoc. M. '38), Constr. Engr., General Elec. Co. (Res., 4230 Beaver Ave.), Fort Wayne, Ind.

WOODWARD, DOUGLAS RUSSELL (Jun. '38), Junior Engr., Water Resources Branch, U. S. Geological Survey (Res., 893 Lancaster St.), Albany, N.Y.

YOUNG, KENNETH (Assoc. M. '38), Cons. Engr., 501 Baum Bldg. (Res., 2039 North 50th St.), Omaha, Nebr.

ZALMANZIG, FRED DODGE (Jun. '38), Research Engr., San Antonio Public Service Co., 201 North St., Mary's St., San Antonio, Tex.

TOTAL MEMBERSHIP AS OF AUGUST 9, 1938	
Members	5,682
Associate Members	6,293
Corporate Members	11,975
Honorary Members	24
Juniors	3,741
Affiliates	78
Fellows	1
Total	15,819

Membership Transfers

BIEDINGER, JOHN ROBERT (Assoc. M. '17; M. '38), Cons. Structural Engr., 1011 Traction Bldg. (Res., 2234 Highland Ave.), Cincinnati, Ohio.

BRINGHURST, JOHN HENRY (Jun. '11; Assoc. M. '15; M. '38), Chf. Engr., Am. Petroleum Co. of Texas, 707 Petroleum Bldg., Houston, Tex.

COUSE, WALTER LEARNED (Assoc. M. '31; M. '38), Engr. and Contr. (Couse & Saunders), 415 Brainard St., Detroit, Mich.

CROCKER, FORREST SAMUEL (Jun. '34; Assoc. M. '38), With Utah-Bechtel-Morrison-Kaiser Co., 1231 First National Bank Bldg., Denver, Colo.

DHILLON, ARJAN SINGH (Jun. '32; Assoc. M. '38), Asst. State Engr., Public Works Dept., Farid Kot State, Farid Kot Palace, Lytton Rd., New Delhi, India.

FENTON, ELY GRAY (Jun. '30; Assoc. M. '38), Asst. Engr. U. S. Engr. Dept. (Res., 420 South Graham St.), Pittsburgh, Pa.

FISCEL, LOUIS O'NIEL (Jun. '31; Assoc. M. '38), County Engr., Pinal County Highway Dept., Box 473, Florence, Ariz.

FRENCH, RICHARD CHARLES (Jun. '27; Assoc. M. '38), Transitman, Grade 4, Dept. of Public Works, New York (Res., 1780 East 48th St., Brooklyn), N.Y.

GILLETTE, PAUL CLIFFORD (Assoc. M. '24; M. '38), Associate Engr., U. S. Engr. Office, Binghamton, N.Y.

HARDING, JAMES CLARKE (Jun. '21; Assoc. M. '28; M. '38), Cons. San. Engr., 11 Park Pl., New York, N.Y.

HENDERSON, ERNEST RAY (Jun. '31; Assoc. M. '38), Surveyman, U. S. Engr. Dept., Box 135, Mineola, Tex.

HICKS, RALPH COMSTOCK (Jun. '31; Assoc. M. '38), 410 Burr Oak St., Albion, Mich.

HOLBROOK, EDWIN CHARLES (Assoc. M. '21; M. '38), Correspondent, U. S. Steel Products Co., Box 285, Manila, Philippine Islands.

HOLDAMPF, CARL RICHARD (Jun. '32; Assoc. M. '38), Civ. Engr., C. S. Whitney, 724 East Mason St. (Res. 5912 North Berkeley Boulevard), Milwaukee, Wis.

HOLLETT, ARTHUR RUSSELL (Jun. '28; Assoc. M. '38), Asst. Dean, School of Eng., Univ. of North Carolina, Chapel Hill, N.C.

KIELY, JOHN ROCHE (Jun. '31; Assoc. M. '38), Res. Engr., Fernandina Pulp & Paper Co., Fernandina, Fla.

LEERMAKERS, HENRY ANTHONY (Jun. '28; Assoc. M. '38), Junior Designer, Bethlehem Steel Co., Fabricated Steel Constr. (Res., 522 West Broad St.), Bethlehem, Pa.

MCCASLAND, STANFORD PAUL (Jun. '30; Assoc. M. '38), Associate Engr., U. S. Bureau of Reclamation, Sacramento, Calif.

McLEAN, ANDREW ALEXANDER (Jun. '28; Assoc. M. '38), Shire Engr. and Secy., Ballan Shire Council, Shire Office, Ballan, Victoria, Australia.

McMILLEN, DALE STEINER (Jun. '31; Assoc. M. '38), Asst. Engr., U. S. Bureau of Reclamation, Box 144, Coulee Dam, Wash.

MELBY, GROVER ODD (Jun. '28; Assoc. M. '38), Transitman, P. R. R., Union Station (Res., 1729 North Narragansett Ave.), Chicago, Ill.

NAGEL, CHARLES AUGUST (Assoc. M. '26; M. '38), Structural Engr., Lawrence B. Peterson, 312 East Wisconsin Ave., Milwaukee (Res., 7038 Cedar St., Wauwatosa), Wis.

OTT, LEONARD EUGENE (Assoc. M. '28; M. '38), Engr., City Light Dept., Seattle (Res., 2308 Burwell Ave., Bremerton), Wash.

PEEL, KENNETH PERCIVAL (Jun. '30; Assoc. M. '38), Asst. Engr., U. S. Engr. Office, Ballona Creek Jetties (Res., 1716 Washington Way), Venice, Calif.

PETERSON, LAWRENCE EUGENE (Assoc. M. '28; M. '38), Cons. Engr., 312 East Wisconsin Ave., Milwaukee, Wis.

RITTER, SAMUEL HENRY (Jun. '30; Assoc. M. '38), Associate Engr., U. S. Engr. Office, Gay Bldg., Little Rock, Ark.

STEVES, BERT FRANCIS (Jun. '31; Assoc. M. '38), Designer, Black & Veatch, 1561 Jackson Ave., Memphis, Tenn.

WORLEY, STEWART EARL (Jun. '28; Assoc. M. '38), Eng. Aide, U. S. Engrs., War Dept. (Res., 758 St. Charles St.), Baton Rouge, La.

REINSTATEMENTS

CLARKE, TERENCE KENNEDY, Assoc. M., reinstated July 18, 1938.

EVANS, WALLACE BRYANT, Assoc. M., reinstated July 14, 1938.

O'BRIEN, JAMES JOHN, Assoc. M., reinstated Aug. 2, 1938.

STEDJE, JOHN JAY, Assoc. M., reinstated July 11, 1938.

URBINO, JACINTO, Assoc. M., reinstated July 18, 1938.

RESIGNATIONS

CARRIER, CHARLES ROBERT, Assoc. M., resigned July 25, 1938.

WOOTEN, MARION FRANK, JR., Jun., resigned July 25, 1938.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

September 1, 1938 NUMBER 9

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years†	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

ADMISSIONS

MEMBER

ATWOOD, BAYARD MCINTOSH, Phoenix, Ariz. (Age 62.) Jun. Administration Asst., U. S. Dept. of Agriculture, Soil Conservation Service, Safford, Ariz. Refers to A. F. Harter, R. A. Hoffman, V. H. Householder, W. R. Hutchins, W. W. Lane, R. V. Leeson, G. L. McLane, E. V. Miller, H. S. Reed, S. Smyth.

BROOKS, WALTER THOMAS, Knoxville, Tenn. (Age 42.) Area Engr., 3rd Area, WPA. Refers to A. J. Bottiger, H. H. Hale, H. D. Palmore, M. U. Snoderly, W. H. Wilson.

CHEW, RICHARD SANDERS, San Francisco, Calif. (Age 67.) Cons. Engr. Refers to C. Derleth, Jr., H. B. Hammill, J. A. Kitts, R. V. LaBarre, A. V. Saph.

COLLIER, SAMUEL MEYER, Hempstead, N.Y. (Age 39.) Draftsman, Port of New York Authority. Refers to E. W. Bowden, W. J. Delaney, J. J. Del Bourgo, H. V. Disney, C. W. Dunham, M. S. Spelman.

HALL, FREDERIC FRANCIS, San Francisco, Calif. (Age 62.) Hall & Pregnoff, Structural Engrs. Refers to H. J. Brunnier, C. Derleth, Jr., W. E. Emmett, B. P. Legare, T. H. Means, F. R. Muhs, W. H. Popert, V. H. Poss, F. M. Randlett, J. B. Wells.

HARDING, ROBERT GEORGE, Salt Lake City, Utah. (Age 43.) Cons. Engr. Refers to R. K. Brown, R. A. Hart, R. B. Ketchum, G. A. Lyon, C. E. Painter, A. Z. Richards, F. H. Richardson.

LAND, JAMES LOVE, Montgomery, Ala. (Age 52.) Materials Engr., Ala. State Highway Comm. Refers to R. P. Boyd, H. D. Burnum, J. A. C. Callan, J. B. Converse, W. Finnell, J. M. Garrett, H. H. Houk, R. D. Jordan, J. H. Mayer, S. B. Slack.

LENDECKE, HUGO ROBERT, Santa Ana, Calif. (Age 42.) Res. Engr. in charge of construction of Santa Margarita River bridge at Oceanside and widening of Zuma Creek and Trancas Creek bridges. Refers to C. E. Andrew, V. A. Endersby, J. Gallagher, I. O. Jahlstrom, F. W. Panhorst, D. R. Warren.

MALCOLM, WILLIAM LINDSAY, Ithaca, N.Y. (Age 54.) Prof. and Director, School of Civ. Eng., Cornell Univ. Refers to F. A. Barnes, S. C. Hollister, H. N. Ogden, J. E. Perry, P. H. Underwood, L. C. Urquhart, C. L. Walker.

MUGLER, RICHARD CARL WILLIAM, New York City. (Age 38.) Secy. and Treas., Heydt-Mugler Co., Inc., Contrs. Refers to W. J. Barney, G. G. Blackmore, J. Feld, A. T. Glassett, C. S. Landers.

MYERS, CHARLES ALBERT, Baton Rouge, La. (Age 38.) Designer, Louisiana Highway Comm. Refers to C. V. Baker, R. L. Barnes, H. B. Henderlite, N. E. Lant, C. T. Nitteberg, B. W. Pegues, F. F. Pillet.

VAN GIESEN, WILLIAM ORSEN, Binghamton, N.Y. (Age 38.) Capt., Corps of Engrs., U. S. Army. Refers to T. R. Agg, H. Austill, C. M. Cade, W. E. Galligan, F. Kerekes, A. Marston, E. G. Plank.

VICKERS, RICHARD CRAGG, Atlanta, Ga. (Age 36.) Engr., Georgia Power Co. Refers to A. T. Beauregard, L. W. Clark, F. E. Hale, A. C. Polk, W. E. Sanford, O. G. Thurlow.

WELLS, HOMER MAGEE, Waco, Tex. (Age 48.) Hydr. Engr. in charge of Field Operations Unit, Water Utilization Sec., Bureau of Agri. Economics, U. S. Dept. of Agriculture. Refers to A. G. Bisset, H. B. Elmendorf, J. E. Hayes, E. B. Keating, L. M. Lawson, W. A. Steenbergen.

ASSOCIATE MEMBER

BAILEY, STEELE, Ann Arbor, Mich. (Age 31.) Res. Engr. on construction of softening-plant addition to Flint (Mich.) filter plant. Refers to G. L. Alt, A. J. Decker, W. R. Drury, W. C. Hoad, R. L. McNamee, E. C. Shoecraft.

BARBER, CHARLES MERRILL, Cleveland, Ohio. (Age 32.) Cons. Structural Engr. for various companies. Refers to R. B. Daudt, C. G. French, J. I. Kuhn, F. L. Plummer, C. W. Schubert.

BETHUNE, RODERICK ARNETT, Little Rock, Ark. (Age 36.) Asst. Field Representative, RFC. Refers to A. Allaire, H. R. Carter, W. Grant, K. W. LeFever, A. M. Lund, D. A. MacCrea.

CRAWFORD, ROBERT EARL, Knoxville, Tenn. (Age 33.) Asst. Engr., Bridges, Southern Ry. Refers to H. H. Hale, C. E. Nichols, T. B. Parker, C. M. Spofford, H. E. Tyrrell, H. T. Welty.

DEPUY, HIRAM, JR., Tacoma, Wash. (Age 33.) Refers to A. Johnson, A. L. Miller, G. L. Parker, B. P. Thomas, R. B. Van Horn.

EBBETS, LAWRENCE OTZEN, Fresno, Calif. (Age 31.) Irvine & Ebbets, Archts. & Engrs., also Senior Architectural Inspector, FHA. Refers to G. F. Carney, J. J. Casey, H. A. Ciuli, A. E. Crenshaw, I. Gottheim, E. R. Huber, K. E. Parker, F. O. Pearce, C. J. Sly, E. L. Soule, F. H. Spitzer.

HARRIS, ROBERT RAY, Louisville, Ky. (Age 33.) Refers to E. S. Chase, F. C. Dugan, G. M.

Fair, J. J. Hinman, Jr., H. W. Streeter, E. L. Waterman, J. S. Watkins.

HARVEY, ADDISON REESE, JR., Montgomery, Ala. (Age 38.) State Mgr., State-Wide Highway Planning Survey, Alabama State Highway Dept. Refers to H. D. Burnum, J. A. C. Callan, W. H. Caruthers, J. M. Garrett, R. S. Garrett, L. Gottlieb, H. H. Houk, R. D. Jordan.

JUMPER, HARRY DRAKE, Los Angeles, Calif. (Age 42.) Mgr., Ready Mixed Concrete Div., Consolidated Rock Products Co. Refers to S. V. Cortelyou, P. L. Feddersohn, G. W. Jones, W. Moore, Jr., D. F. Roberts, A. L. Sonderegger, C. B. Wirsching.

LEVEL, ANDREW, JR., New York City. (Age 29.) Traveling in Venezuela. Refers to F. A. Barnes, D. F. Giboney, J. R. Monaghan, F. H. Nowaczek, C. B. Wigton.

MURRAY, FRANCIS ALOYSIUS, Summit, N.J. (Age 43.) City Engr. and Engr. for Planning Board. Refers to C. P. Bassett, R. T. Betts, A. Blair, J. C. Brigham, G. J. Ray, R. C. Wheeler.

OLSON, OLIFF NEIL, Milwaukee, Wis. (Age 34.) Instructor in Civ. Eng., Marquette Univ. Refers to B. E. Brevik, J. P. Gebhard, L. J. Larson, C. A. Mockmore, S. H. Sims.

PANISH, CHARLES KING, New York City. (Age 31.) Engr. in responsible charge of Flood Control & Hydr. Sec., U. S. Engr. Office. Refers to C. E. Boesch, J. M. Buckley, D. M. Burmister, A. S. Crane, E. L. Daley.

SMITH, DONALD LEE, Mobile, Ala. (Age 28.) Asst. County Engr. and Acting County Engr., Mobile County, and in charge of WPA work. Refers to C. D. Batson, J. B. Converse, G. J. Davis, Jr., H. L. Fisher, S. C. Houser, J. R. Peavy.

VAN GELDER, SPENCER HENRY, San Francisco, Calif. (Age 39.) Contr. on engineering construction. Refers to G. D. Burr, I. E. Flaa, E. F. Haas, F. C. Herrmann, E. R. Huber, L. H. Nishkian.

WALKER, ALBERT ALVIA, Sherman, Tex. (Age 43.) Res. Engr., Div. No. 1, Texas State Highway Dept. Refers to A. M. Brenneke, L. D. Cabaniss, J. C. Feild, H. H. Peel, J. E. Pirie.

JUNIOR

AKUSHKA, MICHAEL PETER, Brooklyn, N.Y. (Age 20.) Refers to L. F. Rader, E. J. Squire.

ALLISON, ALEXANDER, JR., Oakland, Calif. (Age 23.) Refers to R. E. Davis, C. Derleth, Jr., F. S. Foote, B. Jameyson, G. E. Troxell, C. T. Wiskocil.

ANDERSON, O'DEAN, Ogden, Utah. (Age 22.) Refers to H. S. Carter, G. D. Clyde, O. W. Israelsen, H. R. Kepner.

ARENDTS, ELDRON CHARLES, Rock Island, Ill. (Age 23.) With Hydr. Sec., U. S. Engr. Office. Refers to F. M. Dawson, R. B. Kittredge, F. T. Mavis, E. L. Waterman.

ARNOLD, ORAN GLEN, Brownwood, Tex. (Age 24.) Refers to P. M. Ferguson, J. A. Focht.

ATKINSON, HARRY WALTER, Chicago, Ill. (Age 23.) Refers to H. E. Babbitt, J. J. Doland, M. L. Enger, W. C. Huntington, T. C. Shedd.

BAKKEN, THORVALD ENGLUND, Hillsboro, N.Dak. (Age 24.) Rodman, North Dakata State Highway Dept. Refers to H. M. Fitch, W. E. Smith.

BARRATT, HERBERT JOHN, Woodfibre, B.C., Canada. (Age 29.) Engr., British Columbia Pulp & Paper Co., Ltd. Refers to E. A. Cleveland, A. H. Finlay, E. G. Matheson, J. C. Oliver.

BASSE, ARNO, Beaumont, Tex. (Age 22.) Rodman, Texas State Highway Dept. Refers to E. C. H. Bantel, P. M. Ferguson, J. A. Focht, W. E. Suter.

BASTIAN, MARY CLARISSA (Miss), Charlevoix, Mich. (Age 22.) Refers to C. T. Johnston, R. S. Swinton.

BATY, WALTER MARK, Buffalo, N.Y. (Age 25.) Refers to G. E. Barnes, M. S. Douglas, G. B. Earnest, F. L. Plummer.

BEHLING, WESLEY A., Kaysville, Utah. (Age 24.) Refers to H. S. Carter, G. D. Clyde, O. W. Israelsen.

BELL, AUBREY BLAN, Longview, Tex. (Age 29.) Tech. Asst., Texas State Reclamation Dept. Refers to E. C. H. Bantel, P. M. Ferguson, J. A. Focht, R. J. McMahon, T. U. Taylor, H. L. Thackwell.

BISCHOFF, DEAN EDWARD, Geneva, Idaho. (Age 24.) Refers to G. D. Clyde, O. W. Israelsen.

BLATTNER, SANFORD DAVID, Houston, Tex. (Age 26.) Refers to L. E. Conrad, R. W. Epps, L. V. White.

BORMANN, NEVIN WILLIAM, Cando, N.Dak. (Age 21.) Refers to H. M. Fitch, E. R. Griffin.

BOND, RICHARD GUY, Bartlett, N.H. (Age 21.) Asst., Dept. of Civ. Eng., Univ. of New Hampshire. Refers to E. W. Bowler, R. R. Skelton.

BONELL, JOHN ARTHUR, JR., Brookings, S.Dak. (Age 24.) Refers to H. B. Blodgett, H. S. Carter, R. R. Martel, F. Thomas.

BOWERS, DOUGLAS ALBERT, Oklahoma City, Okla. (Age 28.) Road Life Asst., Statewide Highway Planning Survey, Oklahoma State Highway Comm. Refers to G. H. James, D. H. Jones, R. E. Kirkham, C. W. McFerron, C. H. Rightmire, R. G. Saxton, E. R. Stapley.

BRIDGEWATER, CARROLL CALVIN, Wapiti, Wyo. (Age 23.) Rodman, Bureau of Public Roads. Refers to J. E. Kirkham, R. E. Kirkham, R. G. Saxton, E. R. Stapley.

BURNS, PAUL ALEXANDER, New York City. (Age 26.) Draftsman, Kerlow Steel Flooring Co. Refers to C. L. Harris, E. L. Tarof.

CAMI, ROY MORGAN, Thibodaux, La. (Age 21.) Refers to D. Derickson, E. S. Bres.

CAMPBELL, JOSEPH FRANCIS, Mount Pleasant, S.C. (Age 23.) Inspector, Bridge Dept., South Carolina State Highway Dept. Refers to R. C. Johnson, A. E. Johnson, T. K. Legare, W. E. Rowe, R. L. Sumwalt.

CARPER, WILLIAM HUDSON, Fredericksburg, Va. (Age 26.) City Engr. Refers to R. B. H. Begg, D. H. Pletta.

CHANDLER, BENSON, Olympia, Wash. (Age 21.) Refers to R. L. Carter, R. M. Chandler, C. C. More, F. H. Rhodes, Jr.

CHAPMAN, ROBERT BRECKINRIDGE, III, Baltimore, Md. (Age 21.) Refers to J. T. Thompson, A. Wolman.

CHENEY, LLOYD THEODORE, Buffalo, N.Y. (Age 20.) Refers to E. F. Berry, E. F. Church, L. Mitchell, E. F. O'Brien, S. D. Sarason.

CHEVES, LANGDON, Anderson, S.C. (Age 26.) Estimator, Townsend Lumber Co. Refers to E. L. Clarke, F. R. I. Sweeny.

CHIARITO, PATRICK THEODORE, New York City. (Age 21.) Refers to W. Allan, R. E. Goodwin, T. H. Prentice.

COMPTON, AUGUST WALTER, East Cleveland, Ohio. (Age 27.) Asst. Engr., City Eng. Dept. Refers to G. E. Barnes, M. S. Douglas, G. B. Earnest.

CONOVER, CLYDE STUART, Albuquerque, N.Mex. (Age 22.) Refers to J. H. Dorroh, W. A. Laflin.

CORBIN, KEITH MARCUS, Kansas City, Mo. (Age 23.) Refers to G. W. Bradshaw, F. A. Russell.

CORNELISSEN, HENDRIK, Troy, N.Y. (Age 21.) Refers to H. B. Compton, H. O. Sharp.

CORNETT, ROY CHARLES, Chattanoogn, Tenn. (Age 23.) Refers to C. E. S. Bardsley, J. B. Butler, E. W. Carlton, C. V. Mann.

COTTERMAN, ROBERT LEE, Dayton, Ohio. (Age 21.) Refers to C. J. Beiz, E. O. Brown, J. J. Chamberlain, Jr., C. H. Paul, B. T. Schad.

CRAWFORD, CLARK ALVIN, Elmira Heights, N.Y. (Age 21.) Refers to H. C. Bird, W. H. Hall.

DEHART, ROBERT CHARLES, Laramie, Wyo. (Age 21.) Refers to R. D. Goodrich, H. T. Person.

DENMARK, MARION ALEXANDER, Wharton, Tex. (Age 24.) Refers to P. M. Ferguson, J. A. Focht.

DIXON, ARTHUR EVANS, Los Angeles, Calif. (Age 22.) Refers to E. S. Borgquist, J. C. Park.

DOPP, ROBERT HENRY, Key West, Fla. (Age 25.) Refers to T. M. Lowe, P. L. Reed.

DOWD, MUNSON WHITE, El Centro, Calif. (Age 21.) Jun. Eng. Aide, Design Sec., U. S. Engrs. Los Angeles, Calif. Refers to R. R. Martel, F. Thomas.

DRAPER, ELMOND LLEWALLEN, Tuba City, Ariz. (Age 26.) Trail Locater, U. S. Dept. of Interior, CCC. Refers to J. H. Dorroh, H. C. Neuffer, C. W. Wright.

EASON, STEARNS DAVID, Ephrata, Wash. (Age 23.) Rodman, Washington State Highway Dept. Refers to J. R. Griffith, F. Merryfield.

EBBE, EARL EDGAR, Trenton, Mo. (Age 23.) Refers to W. G. Fowler, R. B. B. Moorman, H. Rubey, H. W. Wood, Jr.

EGAN, JOHN ROBERT, Albion, Nebr. (Age 25.) Project Engr., WPA. Refers to C. M. Duff, M. I. Evinger, D. H. Harkness, H. J. Kesner, C. E. Mickey.

FELDHAKE, CLARENCE JOHN, Santa Fe, N.Mex. (Age 31.) Refers to J. H. Dorroh, B. G. Dwyre, T. M. McClure.

FIELDS, KENNETH E., Belmont, Mass. (Age 29.) Graduate Student, Massachusetts Inst. of Technology. Refers to J. B. Babcock, 3d, H. K. Barrows, E. L. Daley, B. C. Dunn, K. C. Reynolds, E. B. Snell, J. H. Stratton, D. W. Taylor.

FISHER, ALBERT STEVEN, Laramie, Wyo. (Age 27.) Refers to R. D. Goodrich, H. T. Person.

FLECK, KENNETH JAMES, Peoria, Ill. (Age 27.) Eng. Apprentice, Caterpillar Tractor Co. Refers to R. A. Caughey A. H. Fuller.

FOARD, CHARLES MANN, Baltimore, Md. (Age 20.) Refers to T. F. Comber, Jr., J. T. Thompson.

FOOTE, EDWARD WATT, Utica, N.Y. (Age 22.) Refers to A. J. Decker, W. C. Hoad.

FOSKETT, PAUL FRANCIS, San Pedro, Calif. (Age 23.) Refers to C. T. Bishop, R. H. Suttie.

FRATE, CHARLES JOSEPH, Milldale, Conn. (Age 21.) Engr., Dept. of Eng., Hartford, Conn., acting as Rodman, Chainman, and Computer. Refers to R. J. Ross, H. O. Sharp.

FULLER, EDWARD HARMON, Blacksburg, Va. (Age 21.) Refers to R. B. H. Begg, D. H. Pletta.

GABBE, RALPH ROY, Hastings, Nebr. (Age 27.) Jun. Hydr. Engr., Soil Conservation Service. Refers to J. A. Allis, L. L. Harrold, H. R. Leach, C. E. Ramser, L. G. Straub.

GARRATT, JOHN NATHAN, Nutley, N.J. (Age 22.) Refers to H. N. Cummings, W. S. LaLonde, Jr.

GENTILICH, JOHN STONE, New Orleans, La. (Age 30.) Jun. Engr., U. S. Waterways Experiment Station. Refers to S. J. Buchanan, G. R. Clemens, F. W. Edwards, N. A. Moore, H. A. Sargent, C. P. Wright.

GLYNN, DESMOND FORD, Upway, Victoria, Australia. (Age 22.) Eng. Draftsman, Melbourne & Metropolitan Board of Works. Refers to L. R. East, A. L. Galbraith, C. H. Kernot, C. W. N. Sexton, I. M. Sutherland.

GOLDMAN, MORTIMER LASKAR, Atlanta, Ga. (Age 21.) Refers to R. P. Black, F. C. Snow.

GOMEZ, AMALIO, San Francisco, Calif. (Age 25.) Refers to T. O. Crow, C. Derleth, Jr.

GOODKIND, HERBERT, New Brunswick, N.J. (Age 22.) Draftsman with Ash, Howard, Needles & Tammen. Refers to H. N. Lendall, E. R. Needles.

GOODWIN, WILLIAM HENRY, JR., Andover, N.H. (Age 26.) Refers to E. W. Bowler, R. R. Skelton.

GOOLDY, MILTON ELLIOTT, Casper, Wyo. (Age 21.) Chainman, U. S. Bureau of Reclamation. Refers to R. D. Goodrich, H. T. Person.

GRIFFITH, JOHN MACK, Ann Arbor, Mich. (Age 24.) Refers to G. L. Alt, J. H. Cissel.

GRIFFITHS, WILLIAM HENRY, JR., Raleigh, N.C. (Age 23.) Soils Laboratory Asst., N.C. State Highway & Public Works Comm. Refers to H. C. Bird, W. H. Hall.

GUYTON, WILLIAM FRANKLIN, Oxford, Miss. (Age 20.) Refers to C. B. Downing, A. B. Hargis.

HANCOCK, JAMES HARVEY, Montgomery, Ala. (Age 27.) Draftsman, Alabama State Highway Dept. Refers to A. C. Barrow, M. M. Boatner, Jr., J. A. C. Callan, H. H. Houk, A. V. Lynn.

HECHMER, WILLIAM LOUIS, Washington, D.C. (Age 24.) Refers to F. A. Biberstein, Jr., A. J. Scullen.

HECHTMAN, ROBERT AARON, Seattle, Wash. (Age 27.) Refers to A. L. Miller, C. C. More, F. H. Rhodes, Jr., R. G. Tyler, R. B. Van Horn.

HIRST, PHILLIP ALEX, Laramie, Wyo. (Age 22.) Refers to R. D. Goodrich, H. T. Person.

HOWELL, HAROLD KENNETH, Manhattan, Kans. (Age 23.) Refers to L. E. Conrad, F. F. Frazier, M. W. Furr, J. B. Hays, C. H. Scholer.

HOXIE, WILBAR MARDEN, Plaistow, N.H. (Age 21.) Refers to E. W. Bowler, R. R. Skelton.

HUCHTING, JOHN FREDERICK, JR., Charleston, S.C. (Age 24.) With M. L. Stephenson Constr. Co. Refers to E. M. Clarke, D. D. Curtis, F. R. I. Sweeny.

HUNTLEY, WAYNE EASTWOOD, Phoenix, N.Y. (Age 24.) Refers to E. F. Berry, E. F. Church, L. Mitchell, E. F. O'Brien, S. D. Sarason.

HYDEN, BAILEY SYLVANIUS, Houston, Tex. (Age 26.) Refers to P. M. Ferguson, S. P. Finch, J. A. Focht.

JOHNSON, CHESTER HERMAN, Topeka, Kans. (Age 23.) Supt., Bldgs. & Grounds, Washburn Coll. Refers to L. E. Conrad, E. R. Dawley, F. F. Frazier, M. W. Furr, C. H. Scholer, L. V. White.

JOHNSON, FRANCIS JOSEPH, Raleigh, N.C. (Age 22.) Jun. Draftsman, Roadway Planning Dept., N.C. State Highway Comm. Refers to T. S. Johnson, C. M. Lambe, C. L. Mann.

JOHNSON, JOHN WALTER, JR., Blacksburg, Va. (Age 20.) Refers to R. B. H. Begg, D. H. Pletta, F. J. Sette.

JONES, WILLIAM ROBERT, Wichita, Kans. (Age 24.) Engr., Board of Park Commrs. Refers to F. F. Frazier, L. V. White.

JOVE, JOSE ANTONIO, Caracas, Venezuela. (Age 29.) Refers to R. A. Caughey, A. H. Fuller, W. E. Galligan, F. Kerekes, R. A. Moyer.

KARR, HORACE MITCHELL, San Francisco, Calif. (Age 22.) Draftsman, Shell Development Co. Refers to R. E. Davis, C. Derleth, Jr., F. S. Foote, H. A. Jacobson.

KENNEDY, ROBERT MALCOLM, San Francisco, Calif. (Age 21.) Refers to R. E. Campbell, C. C. Kennedy, S. B. Morris, E. N. Prouty, F. C. Scobey.

KEPFORD, BURGE BERNARD, Cody, Wyo. (Age 22.) Refers to R. D. Goodrich, H. T. Person.

KERBER, HENRY JOHN, Akron, Ohio. (Age 27.) Timekeeper, Indiana Eng. & Constr. Co. Refers to J. W. Bulger, R. C. Durst.

KHALIFA, MOHAMED KAMAL, Cambridge, Mass. (Age 26.) Refers to A. Casagrande, A. Haertlein.

KING, WILLIAM BYRD, III, Ft. Worth, Tex. (Age 23.) Estimator, Designer, and Detailer, Ft. Worth Structural Steel Co. Refers to J. H. Brillhart, J. H. Murdough.

KISSGEN, VAL EARHART, New Orleans, La. (Age 21.) Refers to E. S. Bres, D. Derickson.

KITE, MAURICE BURTON, Chattanooga, Tenn. (Age 29.) Asst. Structural Engr., TVA. Refers to W. N. Downey, H. L. Fruend.

KLEBAN, THEODORE, Rahway, N.J. (Age 24.) Refers to H. C. Bird, H. P. Hammond.

KOELZER, VICTOR ALVIN, Iowa City, Iowa. (Age 24.) Refers to G. W. Bradshaw, W. G. Fowler, E. W. Lane, W. C. McNown, G. M. March, F. T. Mavis, E. L. Waterman.

KRABBENHOFT, CLIFFORD RAY, Topeka, Kans. (Age 22.) Jun. Engr., Materials Dept., Kansas State Highway Comm. Refers to L. E. Conrad, R. D. Finney, M. W. Furr, R. F. Morse, C. H. Scholer, L. V. White.

KREBILL, ROLAND FREDERICK, Donnellson, Iowa. (Age 22.) Instrumentman, Iowa State Highway Comm. Refers to J. W. Howe, R. B. Kittredge, B. J. Lambert, E. L. Waterman.

KRUCHKOW, NORMAN, Stamford, Conn. (Age 21.) Refers to L. V. Carpenter, D. S. Trowbridge.

KUBO, GIRO GERALD, Tacoma, Wash. (Age 21.) Refers to C. W. Harris, G. E. Hawthorn, A. L. Miller, C. C. More, F. H. Rhodes, Jr., R. G. Tyler, R. B. Van Horn.

KUENNING, WALTER HENRY, Lima, Ohio. (Age 23.) Refers to E. F. Coddington, J. M. Montz, C. T. Morris, J. C. Prior, J. R. Shank, C. E. Sherman, R. C. Sloane.

KUENTZ, CARL LEE, Greenville, Tex. (Age 23.) Rodman, being Inspector on bridge construction, Texas State Highway Dept. Refers to J. H. Murdough, G. W. Parkhill.

KUKUK, CLIFTON CARROL, Rapid City, S.Dak. (Age 22.) Refers to A. A. Chenoweth, E. D. Dake.

LAMP, DONALD GEORGE, Emerson, Nebr. (Age 23.). Project Engr., WPA, South Sioux City. Refers to M. I. Evinger, H. J. Kesner, C. E. Mickey.

LEVIEN, MAURICE BERYL, New York City. (Age 20.) Refers to L. V. Carpenter, D. S. Trowbridge, H. E. Wessman.

LIPMAN, ROBERT CHARLES, Drexel Hill, Pa. (Age 22.) Refers to W. H. Chorlton, F. P. Witmer.

LIPTON, SAMUEL, Cheyenne, Wyo. (Age 22.) Refers to R. D. Goodrich, H. T. Person.

LORENZ, GILBERT GUSTAV, Little Rock, Ark. (Age 26.) Jun. Engr., U. S. Engrs. Refers to J. B. Babcock, 3d, H. K. Barrows, C. B. Breed, J. W. Howard, H. D. Loring.

LUCAS, CHESTER LAURICE, Raleigh, N.C. (Age 23.) Jun. Draftsman, State Highway & Public Works Comm. of North Carolina. Refers to H. C. Bird, W. H. Hall.

LUNDIN, ALFRED LAWRENCE, New York City. (Age 20.) Refers to L. V. Carpenter, D. S. Trowbridge, H. E. Wessman, S. F. Yasines.

MCCLURE, JOHN PHILIP, Laramie, Wyo. (Age 26.) Refers to R. D. Goodrich, H. T. Person.

MCGAUGHY, JOHN BELL, Virginia Beach, Va. (Age 23.) Tech. Asst., Civ. Eng. Div., U. S. Coast Guard. Refers to H. C. Bird, W. H. Hall, A. B. Hargis.

MCKINNON, DEMAR JOHN, Evanston, Wyo. (Age 28.) Refers to J. B. Cleary, J. D. Goodrich, H. T. Person.

MCLAUGHLIN, THOMAS OAKLEY, Woodbridge, N.J. (Age 25.) Draftsman, Ordnance Project, Raritan Arsenal, N.J. Refers to H. N. Lendall, S. S. Steinberg.

MANGANARO, CHARLES ANTHONY, New York City. (Age 21.) Refers to D. S. Trowbridge, H. E. Wessman.

MARSHALL, ARTHUR PHILIP, Corona, N.Y. (Age 23.) Refers to L. V. Carpenter, D. S. Trowbridge, H. E. Wessman.

MATHES, ELLIS LEROY, Boise, Idaho. (Age 25.) Refers to J. E. Buchanan, I. N. Carter, J. W. Howard.

MERRIAM, JOHN LAFAYETTE, San Gabriel, Calif. (Age 26.) Refers to F. J. Converse, R. R. Martel.

MERRIMAN, WAYLAND, Lubbock, Tex. (Age 22.) Draftsman and Instrumentman with H. N. Roberts. Refers to O. V. Adams, J. H. Murdough, G. W. Parkhill, H. N. Roberts.

MINASIAN, JOHN KACHIO, Los Angeles, Calif. (Age 24.) Refers to R. R. Martel, W. W. Michael.

MOORE, NORMAN HARNED, Queens Village, N.Y. (Age 23.) Refers to J. K. Finch, H. O. Sharp.

MOORE, ROBERT SCOTT, Oklahoma City, Okla. (Age 25.) Refers to L. M. Bush, D. L. Wilson, N. E. Wolfard.

MOORE, WALTER LEON, Pasadena, Calif. (Age 22.) Jun. Eng. Aide, U. S. Eng. Div. Refers to F. J. Converse, H. W. Dennis, R. R. Martel, F. Thomas.

MORGAN, CLIFFORD LEON, Davenport, Iowa. (Age 24.) Refers to R. B. Kittredge, E. L. Waterman.

MORGAN, JACK CHARLES, Syracuse, N.Y. (Age 23.) Refers to E. F. Berry, C. R. Hughes, L. Mitchell, S. D. Sarason, M. H. Sturtevant.

MULLER, FRED ADOLF, Brooklyn, N.Y. (Age 23.) Jun. Engr., Anchor Bldgs., Inc. Refers to L. F. Rader, E. J. Squire.

NOVAK, LEO CHARLES, College Station, Tex. (Age 26.) post-graduate student in Civ. Eng., Agricultural & Mechanical Coll. of Texas. Refers to F. Kerekes, J. J. Richey.

ODLEN, MARTIN, Camden, N.J. (Age 22.) Structural Salesman and Estimator, General Iron Works. Refers to J. A. C. Callan, H. H. Houk.

O'NEIL, HUGH MICHAEL, Oakland, Calif. (Age 27.) Structural Designer for Walter Leroy Huber, Civ. Engr. Refers to W. L. Huber, E. M. Knapik.

PARRISH, CHARLES RAYMOND, JR., Sardis, Miss. (Age 24.) Rolled Fill Inspector, U. S. Engrs., Sardis Dam. Refers to R. P. Black, F. C. Snow.

PATTISON, MARTIN OREN, Manhattan, Kans. (Age 22.) Rodman, State Highway Comm. of Kansas. Refers to L. E. Conrad, M. W. Furr.

PETERS, DONALD CAMERON, Milwaukee, Wis. (Age 23.) Jun. Engr., Siesel Constr. Co. Refers to G. E. Hill, S. C. Peters, S. M. Siesel.

PETERSON, CARL HILMER, JR., Fort du Pont, Del. (Age 25.) Refers to N. E. Lant, B. W. Pegues, P. F. Pillet.

PLATT, WILLIAM, Fargo, N.Dak. (Age 21.) Materials Checker, North Dakota State Highway Dept., also acting as Rodman and Draftsman. Refers to H. M. Fitch, E. R. Griffin.

POLSON, GROVER STERLING, Artesia, N.Mex. (Age 21.) With International Geophysics Inc. Refers to G. W. Bradshaw, I. C. Crawford, W. C. McNown.

POTTER, JOHN CLAUDE, JR., Fort DuPont, Del. (Age 23.) 2d Lieut., Corps of Engrs., U. S. Army. Refers to R. T. Brown, N. W. Dougherty.

POWERS, GROVER ORREL, Casper, Wyo. (Age 22.) Refers to R. D. Goodrich, H. T. Person.

PURCHASE, ROY WADE, Hartford, Conn. (Age 22.) With Dept. of Eng. Refers to R. J. Ross, E. R. Wiseman.

PUTMAN, CLARENCE, Bismarck, N.Dak. (Age 25.) Refers to H. M. Fitch, E. R. Griffin.

RADCLIFFE, JACK CLIFFORD, Elizabeth, N.J. (Age 21.) San. Engr., Elizabethtown Water Co. Refers to H. N. Lendall, S. F. Newkirk, Jr., W. Rudolfs.

RAYMOND, JOHN ARTHUR, Hillsboro, N.Dak. (Age 24.) Refers to H. M. Fitch, E. R. Griffin.

RICE, LAURENCE KERR, Cheyenne, Wyo. (Age 24.) Refers to R. D. Goodrich, H. T. Person.

RIMAN, BERNARD B, Rock Island, Ill. (Age 23.) Asst. Draftsman, U. S. Engr. Office, War Dept., Rock Island Dist. Refers to J. C. Penn, M. Rosner, R. L. Stevens.

ROBERTS, JAMES WAID, East Cleveland, Ohio. (Age 23.) Refers to G. E. Barnes, M. S. Douglas, G. B. Earnest, F. L. Plummer.

RODRIGUEZ, GUILLERMO, Ancon, Canal Zone. (Age 27.) Refers to R. B. Kittredge, B. J. Lambert, F. T. Mavis, E. L. Waterman.

ROWLAND, SAMUEL JOHN, Seattle, Wash. (Age 23.) Refers to G. E. Hawthorn, C. C. More, F. H. Rhodes, Jr., R. G. Tyler, R. B. Van Horn.

SCOTT, RONALD FAIRBANKS, Milwaukee, Wis. (Age 23.) Refers to L. M. Gram, R. H. Sherlock.

SERBY, DAVID KAPLAN, Yonkers, N.Y. (Age 20.) Refers to F. A. Barnes, J. E. Perry.

SHANNON, GERALD TILDEN, Vinita, Okla. (Age 23.) Instrumentman, Holway & Neuffer, Engrs. Refers to J. E. Kirkham, E. R. Stapley.

SHELHORSE, WILLIAM HENRY, Atlanta, Ga. (Age 21.) Refers to R. P. Black, C. D. Gibson.

SHERMAN, PRESCOTT ALDEN, McComb, Miss. (Age 23.) Refers to A. B. Hargis, N. H. Rector.

SIEBERT, GEORGE JOSEPH HAMEL, Merion Station, Pa. (Age 23.) Refers to H. C. Berry, W. H. Chorlton, F. P. Witmer.

SIELSKI, MATTHEW CASMIR, Chicago, Ill. (Age 24.) Refers to R. L. Morrison, J. S. Worley.

SIEWERT, HENRY GUST, Sacramento, Calif. (Age 23.) Refers to F. S. Foote, B. Jameyson.

SIMMONS, DARRELL RAYMOND, Enid, Okla. (Age 23.) Refers to J. E. Kirkham, R. E. Kirkham, R. G. Saxton, E. R. Stapley.

SJODAHL, SVEN ERIK, Battle Creek, Mich. (Age 23.) Refers to H. B. Luther, R. W. Renn.

SMITH, GEORGE WIER, Brooklyn, N.Y. (Age 24.) Refers to W. E. Jessup, A. E. Winslow.

SOUDER, BYRON NORVIN, Kansas City, Mo. (Age 21.) Refers to G. W. Bradshaw, I. C. Crawford.

SPIEGEL, ROBERT JACOB, Oberlin, Kans. (Age 23.) Jun. Engr. (Grade B), Kansas State Highway Comm. Refers to W. E. Baldry, L. E. Conrad, M. W. Furr, G. S. Knapp, R. F. Morse, J. B. Spiegel, L. V. White.

SPIRES, HAROLD EMERSON, Phoenix, Ariz. (Age 22.) Refers to E. S. Borgquist, F. C. Kelton, J. C. Park.

STEARNS, RAYMOND GUY, Rock Island, Ill. (Age 26.) Subsurveyman, U. S. Engr. Office, Hydr. Sec. Refers to R. B. Kittredge, E. L. Waterman.

STECKER, WILLIAM WALLACE, Sacramento, Calif. (Age 24.) Refers to B. Jameyson, C. T. Wiskocil.

STEGMAIER, ROBERT BERNARD, JR., Baltimore, Md. (Age 21.) Refers to T. P. Comber, Jr., A. Wolman.

STEPHENS, JOHN LANDERKIN, Everett, Wash. (Age 29.) Refers to H. E. Phelps, M. K. Snyder.

STERLING, PETER, Los Angeles, Calif. (Age 23.) Refers to F. O. Rose, D. M. Wilson.

STIGLER, JESS QUALLS, JR., Birmingham, Ala. (Age 23.) Refers to W. E. Elam, A. B. Hargis.

STILES, ED MILES, Tupelo, Miss. (Age 24.) Refers to J. C. Bridger, D. M. McCain.

SURPRENANT, JAMES ROBERT, Providence, R.I. (Age 26.) Refers to J. B. Babcock, 3d, J. D. Mitsch.

SWATTA, FRANK ALBERT, Ft. Logan, Colo. (Age 23.) Refers to F. M. Dawson, R. B. Kittredge, B. J. Lambert, E. W. Lane, C. T. G. Looney, F. T. Mavis, E. L. Waterman.

TAYLOR, BENSON THOMAS, Austin, Tex. (Age 28.) Statistician, State Wide Planning Survey.